A CAHNERS PUBLICATION INTERNATIONAL EDITION AUGUST 20, 1987

# EDN®



SPECIAL ISSUE:
Military electronics

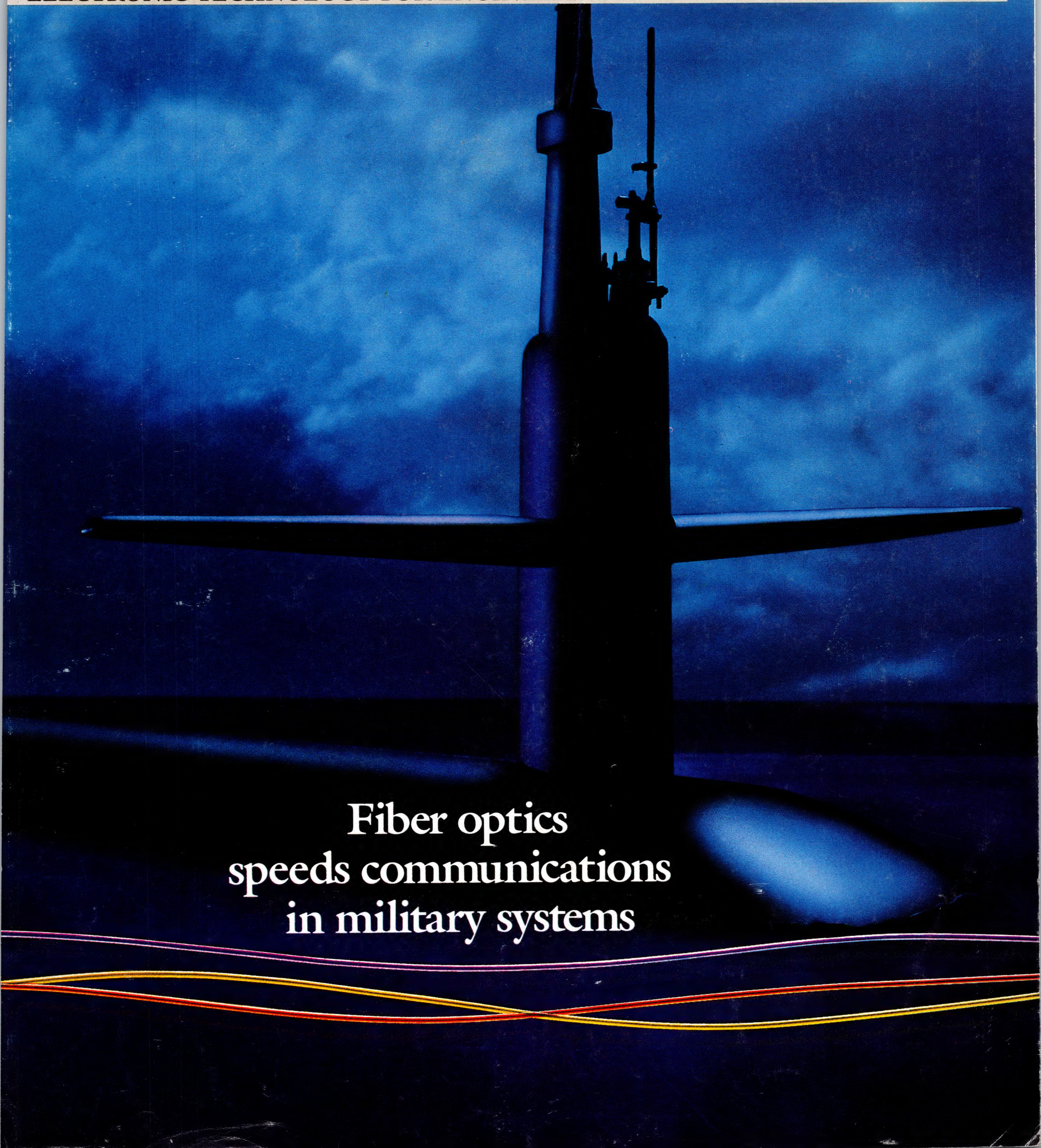
Defense Data Network

Software documentation for military projects

Choosing Ada compilers

Military-grade GaAs ICs

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS



## Fiber optics speeds communications in military systems

Now that the DOD is rethinking the order of its mil spec standards, which one should you shoot for?

Well, when it comes to military PAL® devices, you can't miss. Simply set your sights on Monolithic Memories.

You see, we have more PAL devices qualified to the highest military standards, JAN38510 and the Standard Military Drawing Program, than anybody else. (See list below.)

Even our newest PAL devices, from high-speed ECL to low-power CMOS, are already slated for Standard Military Drawing release.

So whether the DOD moves its standards or leaves them right where they are, you'll be right on target.

For a copy of our new Military Products Short Form Catalog, call your local Monolithic Memories representative or qualified military distributor.

Monolithic Memories, Military Products Division, 2175 Mission College Blvd., Santa Clara, CA 95054. (800) 222-9323.

**Monolithic Memories** MMI

| PAL Family | Generic Part Number | Std MIL Drawing | Replacement JAN Specification Part # |
|---|---|---|---|
| **Medium 24A** | PAL20L8AMJS883B | 8412901LA | M38510/50501BJX |
| | PAL20L8AML883B | 84129013C | M38510/50501B3X |
| | PAL20L8AMW883B | 8412901KA | – |
| | PAL20R8AMJS883B | 8412902LA | M38510/50502BJX |
| | PAL20R8AML883B | 84129023C | M38510/50502B3X |
| | PAL20R8AMW883B | 8412902KA | – |
| | PAL20R6AMJS883B | 8412903LA | M38510/50503BJX |
| | PAL20R6AML883B | 84129033C | M38510/50503B3X |
| | PAL20R6AMW883B | 8412903KA | – |
| | PAL20R4AMJS883B | 8412904LA | M38510/50504BJX |
| | PAL20R4AML883B | 84129043C | M38510/50504B3X |
| | PAL20R4AMW883B | 8412904KA | – |
| **Medium 24XA Exclusive OR** | PAL20L10AMJS883B | 8412905LA | – |
| | PAL20L10AML883B | 84129053C | – |
| | PAL20X8AMJS883B | 8412906LA | – |
| | PAL20X8AML883B | 84129063C | – |
| | PAL20X10AMJS883B | 8412907LA | – |
| | PAL20X10AML883B | 84129073C | – |
| | PAL20X4AMJ883B | 8412908LA | – |
| | PAL20X4AML883B | 84129083C | – |
| **Medium 20A-4 ¼ Power** | PAL16L8A-4MJ883B | 8506501RA | – |
| | PAL16L8A-4ML883B | 85065012C | – |
| | PAL16R8A-4MJ883B | 8506502RA | – |
| | PAL16R8A-4ML883B | 85065022C | – |
| | PAL16R6A-4MJ883B | 8506503RA | – |
| | PAL16R6A-4ML883B | 85065032C | – |
| | PAL16R4A-4MJ883B | 8506504RA | – |
| | PAL16R4A-4ML883B | 85065042C | – |
| **Medium 20B** | PAL16L8BMJ883B | 8515501RA | – |
| | PAL16L8BML883B | 85155012C | – |
| | PAL16R8BMJ883B | 8515502RA | – |
| | PAL16R8BML883B | 85155022C | – |
| | PAL16R6BMJ883B | 8515503RA | – |
| | PAL16R6BML883B | 85155032C | – |
| | PAL16R4BMJ883B | 8515504RA | – |
| | PAL16R4BML883B | 85155042C | – |
| **Medium 20B-2 ½ Power** | PAL16L8B-2MJ883B | 8515505RA | – |
| | PAL16L8B-2ML883B | 85155052C | – |
| | PAL16R8B-2MJ883B | 8515506RA | – |
| | PAL16R8B-2ML883B | 85155062C | – |
| | PAL16R6B-2MJ883B | 8515507RA | – |
| | PAL16R6B-2ML883B | 85155072C | – |
| | PAL16R4B-2MJ883B | 8515508RA | – |
| | PAL16R4B-2ML883B | 8515508SA | – |
| | | | – |

PAL is a registered trademark of Monolithic Memories.



CIRCLE NO 194

# Aim high.

| PAL Family | Generic Part Number | Std MIL Drawing | Replacement JAN Specification Part # |
|---|---|---|---|
| **Small 20 Combinatorial** | PAL10H8MJ883B | 8103501RA | M38510/50301BRXA |
| | PAL10H8ML883B | 81035012C | M38510/50301B2XC |
| | PAL10H8MF883B | 8103501SC | – |
| | PAL12H6MJ883B | 8103502RA | M38510/50302BRXA |
| | PAL12H6ML883B | 81035022C | M38510/50302B2XC |
| | PAL12H6MF883B | 8103502SC | – |
| | PAL14H4MJ883B | 8103503RA | M38510/50303BRX |
| | PAL14H4ML883B | 81035032C | M38510/50303B2X |
| | PAL14H4MF883B | 8103503SC | – |
| | PAL16H2MJ883B | 8103504RA | M38510/50304BRX |
| | PAL16H2ML883B | 81035042C | M38510/50304B2X |
| | PAL16H2MF883B | 8103504SC | – |
| | PAL16C1MJ883B | 8103505RA | M38510/50305BRX |
| | PAL16C1ML883B | 81035052C | M38510/50305B2X |
| | PAL16C1MF883B | 8103505SC | – |
| | PAL10L8MJ883B | 8103506RA | M38510/50306BRX |
| | PAL10L8ML883B | 81035062C | M38510/50306B2X |
| | PAL10L8MF883B | 8103506SC | – |
| | PAL12L6MJ883B | 8103507RA | M38510/50307BRX |
| | PAL12L6ML883B | 81035072C | M38510/50307B2X |
| | PAL12L6MF883B | 8103507SC | – |
| | PAL14L4MJ883B | 8103508RA | M38510/50308BRX |
| | PAL14L4ML883B | 81035082C | M38510/50308B2X |
| | PAL14L4MF883B | 8103508SC | – |
| | PAL16L2MJ883B | 8103509RA | M38510/50309BRX |
| | PAL16L2ML883B | 81035092C | M38510/50309B2X |
| | PAL16L2MF883B | 8103509SC | – |
| **Medium 20A** | PAL16L8AMJ883B | 8103607RA | M38510/50401BRX |
| | PAL16L8AML883B | 81036072C | M38510/50401B2X |
| | PAL16L8AMW883B | 8103607SA | – |
| | PAL16R8AMJ883B | 8103608RA | M38510/50402BRX |
| | PAL16R8AML883B | 81036082C | M38510/50402B2X |
| | PAL16R8AMW883B | 8103608SA | – |
| | PAL16R6AMJ883B | 8103609RA | M38510/50403BRX |
| | PAL16R6AML883B | 81036092C | M38510/50403B2X |
| | PAL16R6AMW883B | 8103609SA | – |
| | PAL16R4AMJ883B | 8103610RA | M38510/50404BRX |
| | PAL16R4AML883B | 81036102C | M38510/50404B2X |
| | PAL16R4AMW883B | 8103610SA | – |
| **Medium 20A-2 ½ Power** | PAL16L8A-2MJ883B | 8103611RA | M38510/50407BRX |
| | PAL16L8A-2ML883B | 81036112C | M38510/50407B2X |
| | PAL16L8A-2MW883B | 8103611SA | – |
| | PAL16R8A-2MJ883B | 8103612RA | M38510/50408BRX |
| | PAL16R8A-2ML883B | 81036122C | M38510/50408B2X |
| | PAL16R8A-2MW883B | 8103612SA | – |
| | PAL16R6A-2MJ883B | 8103613RA | M38510/50409BRX |
| | PAL16R6A-2ML883B | 81036132C | M38510/50409B2X |
| | PAL16R6A-2MW883B | 8103613SA | – |
| | PAL16R4A-2MJ883B | 8103614RA | M38510/50410BRX |
| | PAL16R4A-2ML883B | 81036142C | M38510/50410B2X |
| | PAL16R4A-2MW883B | 8103614SA | – |

**Military Package Designators:**

R = 20 lead ¼ x 1¹⁄₁₆ dual-in-line
S = 20 lead ¼ x ½ Flatpack
2 = 20 Terminal .350 x .350 Leadless Chip Carrier
K = 24 lead ⅜ x ⅝ Flatpack
L = 24 lead ¼ x 1¼ Dual-in-Line
3 = 28 Terminal .450 x .450 Leadless Chip Carrier

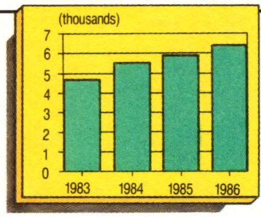
**MMI Package Designators:**

J = Ceramic DIP
F = Bottom Brazed Flatpack
L = Leadless Chip Carrier
W = Cerpak
JS = 24 pin Cerdip

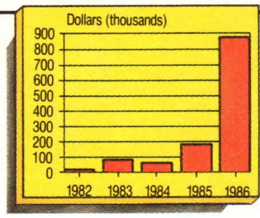
# How to hit a moving target.

# Standards Update

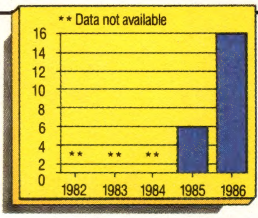
## Uncle Sam Cracks Down on Computer Interference



The rising level of complaints to the FCC...



...caused it to issue more fines...



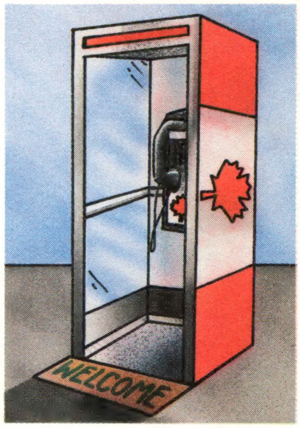
...and refer 15 cases for criminal prosecution.

Last Fall's COMDEX show in Las Vegas had a new kind of visitor. Federal marshals were there to seize equipment the FCC had tagged as non-compliant and to serve notice that arrests may follow. The computers were found to be in violation of Part 15 of the FCC rules, which bans sales of most electronic hardware unless tested for compliance.

The event did not surprise most computer executives, some of whom paid their share of more than $800,000 in fines issued by the FCC last year. Said one disgruntled manager, "These guys walk around here like Matt Dillon."

The need to comply has spawned a whole new kind of test business, companies specially skilled in designing and testing for compliance. One of these, the Boxborough, MA-based laboratory of Dash, Straus & Goodhue, combines testing, design and even legal services under one roof, permitting manufacturers to go to COMDEX with their minds on sales, not sanctions. The company even offers a "Guaranteed Rate/Guaranteed Date" plan under which equipment is tested, modified for compliance, and retested per FCC standards for a fixed price guaranteed in advance. The laboratory has been accredited by the National Bureau of Standards for telecommunications and emissions testing, and can be reached at 617-263-2662.

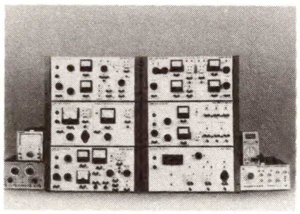
## Canada Lays Out the Welcome Mat for Telecom Firms

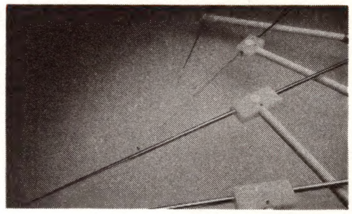



The Canadian government has swung its doors wide open for US telecom manufacturers. The open door policy is a welcome change for US manufacturers who have found most foreign markets closed to their goods. Canada's free trade telecom policy has allowed savvy manufacturers to increase their sales by up to 20%. But to sell north of the border, firms still need to follow a few simple steps. Most importantly, the equipment has to be registered under Canadian Standard CS-03, roughly equivalent to the FCC's interconnect regulations in Part 68. The government of Canada has already approved a number of firms in the United States to do the required telecom testing and submissions. One such firm, Dash, Straus & Goodhue of Boxborough, MA (617-263-2662), has seen a sharp rise in requests for Canadian approvals, especially among the industry's most successful firms. "There seems to be a correlation between economic success and willingness to enter foreign markets," says firm founder Glen Dash.

Elsewhere in the world, telecom markets are opening. Dash, Straus & Goodhue is currently performing submissions for telecom equipment in both the United Kingdom and Japan. New efforts within the Common Market (EC Directive 86/361/EEC) may make one unified approval scheme throughout Western Europe a reality within two to three years.

## Fed's Own Instruments Help Manufacturers Comply





What kind of tools can best convince an agency that equipment complies? Why, their own, of course. Now the FCC's own designs are available through a company called Compliance Design. Key to emissions compliance is the use of the **Roberts Antenna**® developed for the FCC in the 1950's. Willmar Roberts, its inventor, is a former Assistant Chief Engineer of the FCC Laboratory in Laurel, MD.

The antennas are renowned for their near-lossless characteristics. Compliance Design, the exclusive vendor of the Roberts brand, also offers a complete laboratory assembly package. The firm will supply antennas, masts, turntables, site design; and will even perform the crucial "site attenuation" tests the FCC requires. The Boxborough, MA-firm can be reached at 617-264-4668.

For telecom manufacturers, Compliance Design also supplies a **Part 68 Workstation**™ containing everything that's needed to comply with FCC, CS-03 (Canada) and EIA standards. The Workstation makes setting up Part 68 laboratories practical for just about everyone.

## Safety Violation Sends a CEO to Jail

On February 13, Kenneth Oden, prosecutor for Travis County, TX, won a landmark case that sent shivers down corporate backbones nationwide. For the first time, company executives were sentenced to jail terms for negligence that cost a worker his life. The case highlighted a nationwide trend in which prosecutors are holding executives criminally liable for the death of a customer or employee.

For makers of EDP, medical and telecom equipment, safety on the job generally means getting their products UL® listed. Listing is a recognition that the product meets UL's standards for fire, shock, energy and mechanical hazards; listing is a legal requirement of certain municipalities. In those places, a death caused by a non-compliant product could give rise to the same charge of gross negligence which caused Travis County executives to be sentenced to jail.

Overseas, marks such as Canada's CSA and West Germany's GS are required, and foreign courts have been even less tolerant of corporate negligence than have our own. With the profusion of worldwide standards, obtaining those marks has proven to be quite a chore. Fortunately, certain key test labs have set up liaison services which permit worldwide product approvals at one location. Dash, Straus & Goodhue is one such lab and is regularly visited by agents of UL, CSA and West German TüV. Required marks for fourteen countries can be initiated from DS&G's location. Since the Travis County case, according to execs, its business has been brisk. Dash, Straus & Goodhue, Inc. can be reached at 617-263-2662.

UL® SA® GS®

Dash, Straus & Goodhue, Inc., 593 Massachusetts Avenue, Boxborough, MA 01719 617-263-2662


# value-packed filters from $9.95

dc to 3GHz

- less than 1dB insertion loss over entire passband
- greater than 40dB stopband rejection
- 5 section, 30dB per octave roll-off
- VSWR less than 1.7 (typ)
- over 100 models, immediate delivery
- meets MIL-STD-202
- rugged hermetically sealed package (0.4 x 0.8 x 0.4 in.)
- BNC, Type N, SMA available

finding new ways ...
setting higher standards

**Mini-Circuits**

A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Domestic and International Telexes: 6852844 or 620156

| LOW PASS Model *LP- | 10.7 | 30 | 50 | 70 | 100 | 150 | 200 | 300 | 450 | 550 | 600 | 750 | 850 | 1000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min. Pass Band (MHz) DC to | 10.7 | 32 | 48 | 60 | 98 | 140 | 190 | 270 | 400 | 520 | 580 | 700 | 780 | 900 |
| Max. 20dB Stop Frequency (MHz) | 19 | 47 | 70 | 90 | 147 | 210 | 290 | 410 | 580 | 750 | 840 | 1000 | 1100 | 1340 |

Prices (ea.): P $9.95 (6-49), B $24.95 (1-49), N $27.95 (1-49), S $26.95 (1-49)

| HIGH PASS Model *HP- | | 50 | 100 | 150 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pass Band (MHz) | start, max. | 41 | 90 | 133 | 185 | 290 | 395 | 500 | 600 | 700 | 780 | 910 | 1000 |
| | end, min. | 200 | 400 | 600 | 800 | 1200 | 1600 | 1600 | 1600 | 1800 | 2000 | 2100 | 2200 |
| Min. 20dB Stop Frequency (MHz) | | 26 | 55 | 95 | 116 | 190 | 290 | 365 | 460 | 520 | 570 | 660 | 720 |

Prices (ea.): P $12.95 (6-49), B $27.95 (1-49), N $30.95 (1-49), S $29.95 (1-49)

*Prefix P for pins, B for BNC, N for Type N, S for SMA    *example:* **PLP-10.7**

**CIRCLE NO 170**

C105 REV. C

# tiny SPDT switch

## dc to 6GHz... $32.95 (1-24)


Tough enough to pass stringent MIL-STD-202 tests, useable from dc to 6GHz operation, and smaller than most RF switches, Mini-Circuits' hermetically-sealed KSW-2-46 offers a new, unexplored horizon of applications. Unlike pin diode switches that become ineffective below 1MHz, this GaAs switch can operate down to dc with control voltage as low as -5V, at a blinding 2ns switching speed.

Despite its extremely tiny size, only 0.185 by 0.185 by 0.06 in., the KSW-2-46 provides 50dB isolation (considerably higher than many larger units) and insertion loss of only 1dB. The surface-mount unit can be soldered to pc boards using conventional assembly techniques. The KSW-2-46, priced at only $32.95, is yet another example of components from Mini-Circuits with unbeatable price/performance.

***Switch fast... to Mini-Circuits' KSW-2-46***

SPECIFICATIONS

| | | |
|---|---|---|
| FREQ. RANGE | dc-4.6 | GHz |
| INSERT. LOSS (db) | typ | max |
| dc-200MHz | 0.9 | 1.1 |
| 200-1000MHz | 1.0 | 1.3 |
| 1-4.6GHz | 1.3 | 1.7 |
| ISOLATION (dB) | typ | min |
| dc-200MHz | 60 | 50 |
| 200-1000MHz | 45 | 40 |
| 1-4.6GHz | 30 | 23 |
| VSWR (typ) | 1.3:1 | |
| SW. SPEED (nsec) | | |
| rise or fall time | 2(typ) | |
| MAX RF INPUT (dBm) | | |
| up to 500MHz | +17 | |
| above 500MHz | +27 | |
| CONTROL VOLT. | -8V on, OV off | |
| OPER/STOR TEMP. | -50 to +100°C | |
| **PRICE** | **$32.95** (1-24) | |

finding new ways...
setting higher standards

**Mini-Circuits**

A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Fax (718) 332-4661 Domestic and International Telexes: 6852844 or 620156

C 117 REV.ORIG.

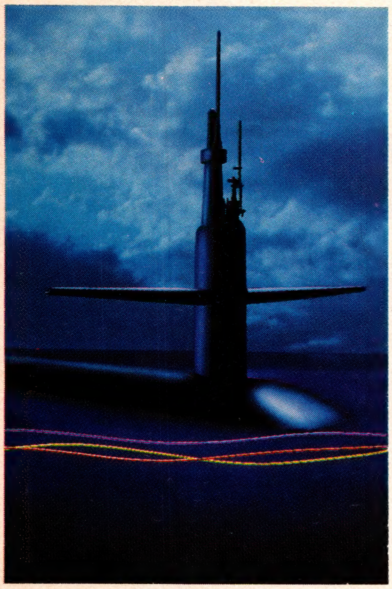
CIRCLE NO 169

Volume 32, Number 17

# EDN

August 20, 1987

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS



***On the cover:*** *Fiber-optic components—fibers and cables, connectors, couplers, detectors, and transceivers—are finding a niche in military applications. See pg 114. (Photo courtesy Corning Glass Works)*

## SPECIAL ISSUE: MILITARY ELECTRONICS

## DESIGN FEATURES

**Special Report: Military fiber-optic components** 114

The last decade has seen rapid growth in the field of lightwave technology. Although most of the R&D efforts have focused on telecommunications applications, interest in fiber optics for military environments is on the increase.—*Tom Ormond, Senior Editor*

**Choose Ada compiler carefully for simulator software** 133

By identifying simulator-program requirements, you can evaluate how well specific Ada compilers and tools will suit real-time and other applications.—*Matt Narotam, Cliff Layton, and John Slish, Burtek Inc*

**Modularity is key to interfacing to the Defense Data Network** 147

When designing an interface to connect to the DDN, you're better off using small, independent software modules and separate hardware functions.—*Michael E Kubat, Unisys Corp*

**DC/DC converter can operate through nuclear blasts** 163

With an off-the-shelf, radiation-hardened dc/dc converter, you can design a power system that could operate continuously even if subjected to the transient radiation of a nuclear explosion.—*Elaine P Bondos and Larry L Longden, IRT Corp*

**Hybrid modules help you implement a 1553B interface** 173

By using standard, off-the-shelf hybrid modules, you can implement an intelligent interface between your 1553 subsystems and host subsystem without hampering the host's performance.—*Daryl C Josephson, ILC Data Device Corp*

**EDN's DSP Project—Part 2** 183

This second in EDN's 4-part series on digital-signal processing surveys DSP tools that help you bypass the maze of algorithmic convolutions and guide you over the hurdles to creating and testing your DSP design with comparative simplicity.—*David Shear, Regional Editor*

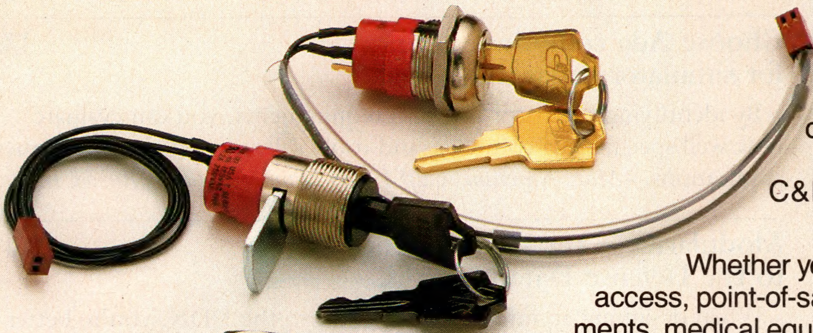
*Continued on page 7*

EDN®(ISSN 0012-7515) is published 38 times a year by Cahners Publishing Co, a Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158. William M Platt, President; Terrence M McDermott, Executive Vice President; Jerry D Neth, Vice President of Publishing Operations; J J Walsh, Financial Vice President/Magazine Division; Thomas J Dellamaria, Vice President Production & Manufacturing; Frank Sibley, Group Vice President.

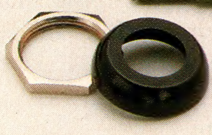
Saul Goldweitz, Chairman; Ronald G Segel, President and Chief Executive Officer; Robert L Krakoff, Executive Vice President. Circulation records maintained at Cahners Publishing Co, 270 St Paul St, Denver, CO 80206. Second class postage paid at Denver, CO 80202 and additional mailing offices. Postmaster: Send address changes to EDN®, 270 St Paul St, Denver, CO 80206.

BPA ABP

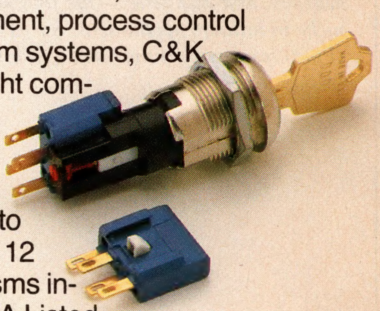
# YOUR BEST PROTECTION: C&K® SWITCHLOCKS

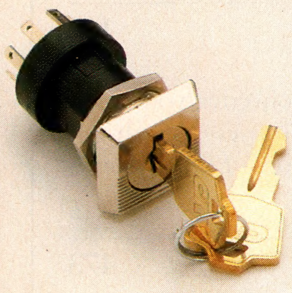


From simple electrical lockout to high security mechanical lockout with electrical control, C&K Components offers the most complete line of Switchlocks.



Whether you want to control computer access, point-of-sale terminals, test instruments, medical equipment, process control systems, security and/or alarm systems, C&K Components can provide the right combination of value added features at the right cost to meet your specifications.

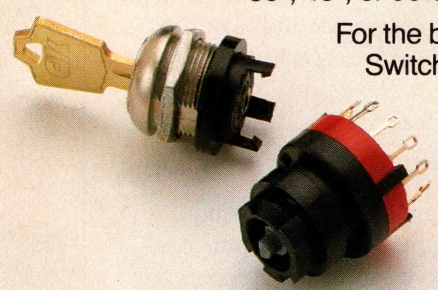


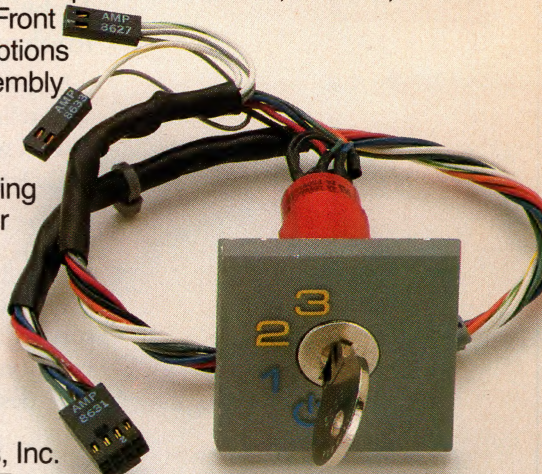


- Standard and instrument grade switching up to four poles
- Power ratings from low-level up to 12 amps
- From three to seven tumbler mechanisms including MEDECO high security locks
- UL/CSA Listed
- Shorting or nonshorting contacts
- Special harnesses, finishes, latches and cosmetic designs
- Front or back panel mounting
- Anti-static options
- 30-, 45-, or 90-degree indexing
- Modular assembly

For the best protection, specify C&K Switchlocks. Send us your specs and we'll send you a free engineering sample. Call or write for our FREE literature.

1-800-334-7729





C&K COMPONENTS, INC. 1957–1987 30th ANNIVERSARY

C&K®

C&K Components, Inc.
2035 Highway 70 East
Clayton, NC 27520-0687

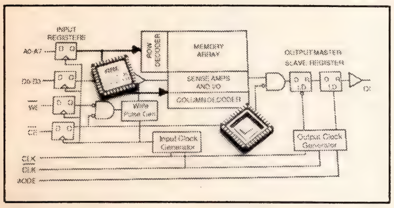
**The Primary Source Worldwide®...**

See us at MIDCON Booth #s 1149-1151

CIRCLE NO 168

*Continued from page 5*






***The inherent performance advantages** of gallium arsenide—high-frequency capability, fast switching, good radiation tolerance, and the potential for high-temperature operation and low power dissipation—are attracting the military to GaAs devices for use in satellites and radar, ECM, and C³I systems (pg 63).*

## DESIGN FEATURES *(Continued)*

### Memory-mapped coprocessor speeds floating-point math — 203

By using a memory-mapped, low-latency coprocessor in your computer design, you can accelerate the machine's floating-point calculations while maintaining software compatibility with off-the-shelf compilers.—*Mauro Bonomi and Christopher Tice, Weitek Corp*

### Designer's Guide to Micropower Circuits—Part 2 — 219

Part 2 completes this series with coverage of the types of micropower circuits and techniques required for implementing A/D converters, V/F converters, low-power regulator circuits, and a sample/hold circuit. —*Jim Williams, Linear Technology Corp*

## TECHNOLOGY UPDATE

### Off-the-shelf GaAs ICs serve both military and commercial applications — 63

Although it isn't likely that gallium arsenide will replace silicon in large-volume, low-performance (by GaAs standards) applications, GaAs ICs have found a niche in high-performance environments. —*Dave Pryce, Associate Editor*

### CASE tool kits tailor DoD-STD-2167 requirements for software documentation — 81

Proponents of computer-aided software engineering packages make optimistic claims for CASE's ability to streamline the analysis and design of large-scale software projects.—*Margery S Conner, Regional Editor*

## PRODUCT UPDATE

**Single-chip microcontroller** — 93

## DESIGN IDEAS

**Power-MOSFET IC drives pin diodes** — 243
**Subroutine plots data from Basic programs** — 244
**Proximity sensor is battery operated** — 250
**Circuit provides 16-bit R/D conversion** — 252
**Controller automatically adjusts fan speed** — 254

*Continued on page 9*

Advertising and editorial offices: 275 Washington St, Newton, MA 02158. Phone (617) 964-3030. Subscription offices: 270 St Paul St, Denver, CO 80206. Phone (303) 388-4511. EDN® is circulated without charge to those qualified. Subscription to others: US, $95/year, $6/copy; Canada and Mexico, $110/year, $8/copy; Europe Air Mail, $135/year, $10/copy; all other nations surface mail, $135/year, $10/copy; all other nations Air Mail, $200/year. Special issue prices may vary. Send requests for qualification forms and/or change of address to subscription office.


# AUTOMATIC SCHEMATIC.

**FUTUREDESIGNER: DRAW LESS. DESIGN MORE.** Introducing FutureDesigner™ — the only advanced design entry workstation that lets you describe your circuit in compact, high-level terms and create more complex designs faster. FutureDesigner's flexible, new techniques encourage creativity and experimentation, helping you produce innovative products quickly and more accurately.

**MULTIPLE DESIGN ENTRY MODES FOR SPEED AND FLEXIBILITY.** Describe your circuit with any combination of structural and behavioral representations. Use schematics to enter the structural portions of the design, such as data paths in a memory array. For portions easier to describe behaviorally, like sequencers or decoders, simply enter equations, truth tables or state diagrams using on-screen input forms.

**ADVANCED DESIGN VERIFICATION HELPS YOU GET IT RIGHT THE FIRST TIME.** For the behavioral portions of your design, use FutureDesigner as a "what if" tool to try different design approaches. Immediately verify that your circuit works as you intended. For the structural portions, design check tools detect and help you correct connectivity and other common design errors. Together these features significantly shorten the design iteration cycle.

**LOGIC SYNTHESIS CONVERTS YOUR EQUATIONS INTO SCHEMATICS.** Once you've entered equations, state diagrams or truth tables, FutureDesigner's logic synthesizer eliminates redundant circuitry and optimizes your design for size/speed trade-offs. FutureDesigner is the only design entry workstation that will then automatically produce the correct schematics and integrate them with the total structural design.

**MORE CHOICES IN TECHNOLOGIES, VENDORS AND SYSTEMS.** FutureDesigner is technology independent. Choose the most convenient mix of TTL, PLDs, gate arrays or other ASICs from a wide range of semiconductor manufacturers. You can easily migrate from one technology to another without redesign.

FutureDesigner output is an industry standard, widely accepted by engineering service bureaus and semiconductor vendors. You'll also have access to both FutureNet® and other CAD systems for simulation and PCB layout.

Call us today and learn how a FutureDesigner workstation gives you the flexibility and accuracy to design innovative products faster.

**1-800-247-5700**
**Dept. 703**

FutureNet
A Data I/O Company

**Data I/O Corporation** 10525 Willows Road N.E., P.O. Box 97046, Redmond, WA 98073-9746, U.S.A. (206) 881-6444/Telex 15-2167
**FutureNet** 9310 Topanga Canyon Boulevard, Chatsworth, CA 91311-7528 (818) 700-0691/Telex 910-494-2681
**Data I/O Canada** 6725 Airport Road, Suite 302, Mississauga, Ontario L4V 1V2 (416) 678-0761/06968133
**Data I/O Europe** World Trade Center, Strawinskylaan 633, 1077 XX Amsterdam, The Netherlands (20) 622866/Telex 16616 DATIO NL
**Data I/O Japan** Sumitomoseimei Higashishinbashi Bldg., 8F, 2-1-7, Higashi-Shinbashi, Minato-ku, Tokyo 105, Japan (03) 432-6991/Telex 2522685 DATAIO J



**CIRCLE NO 167**

*Continued from page 7*

EDN

August 20, 1987



## EDITORIAL 59

The Department of Commerce offers many programs that can ease small- and medium-size companies into the export market.

## NEW PRODUCTS

Components & Power Supplies ....261
Integrated Circuits ....268
Computers & Peripherals ....283
Test & Measurement Instruments ....299
CAE & Software Development Tools ....308

## PROFESSIONAL ISSUES 327

Lauren Christopher: Zooming in on digital ICs for television.
*—Deborah Asbrand, Associate Editor*

## LOOKING AHEAD 355

F-O component market to reach $3.5B by 1994 . . . Major thin-film markets to grow at 15% average rate.

## DEPARTMENTS

News Breaks ....21
News Breaks International ....24
Signals & Noise ....30
Calendar ....46
Readers' Choice ....100
Leadtime Index ....104
Literature ....319
New Books ....323
Business/Corporate Staff ....325
Career Opportunities ....330
Advertisers Index ....353

**Cahners Publishing Company** ☐ A Division of Reed Publishing USA ☐ Specialized Business and Consumer Magazines for Building & Construction ☐ Interior Design ☐ Electronics & Computers ☐ Foodservice & Lodging ☐ Manufacturing ☐ Book Publishing & Libraries ☐ Medical & Health Care ☐ Child Care/Development

# There's only one thing our FIFOs won't do that our competitors' will. Eat power.

In fact, Plessey's MV66000 FIFOs consume a maximum of 40mA. That's almost half the current of the lowest power CMOS FIFO currently available. Anywhere.

And our FIFOs are available now. In quantity. (Unlike some of our competitors).

Plessey's 66000 Series is cascadable to 25MHz. Guaranteed. (That's something our competitors won't do).

If you should need even higher speed operation, Plessey's 65000 Series accommodates today's fastest clock rates. (Think in terms of 40MHz). All without the large power requirements of slower NMOS and Bipolar FIFOs.

And Plessey has the only FIFOs with extremely low standby currents. Our fully static CMOS design means that standby currents less than 10mA are experienced. Even at 5.5 volts.

**The family**

| | |
|---|---|
| MV 66000 | 64x4,5,9 bit FIFOs, 25 MHz |
| MV 65000 | 64x4,5,9 bit FIFOs, 40 MHz |
| MV 61900 | 1Kx9 bit FIFOs, 10 MHz |

Package options include ceramic and plastic DIL and LCC.

Plessey FIFOs are pin compatible with MMI, Cypress, TRW and others. In 4, 5 and 9 bit widths. With or without 3-state outputs.

So you can replace those power-hungry FIFOs with Plessey's CMOS FIFOs. They do everything our competitors' do. For less power.

Call customer service in Swindon (0793) 726666. Fax: (0793) 726666 Ext. 250. After-hours Fax: (0793) 729412. Tx: 444410. In the United States, call (800) 247-4840 or (714) 472-0303. Telex 701464. Fax: (714) 770-0627.

**PLESSEY**

## Where great systems come from small packages.

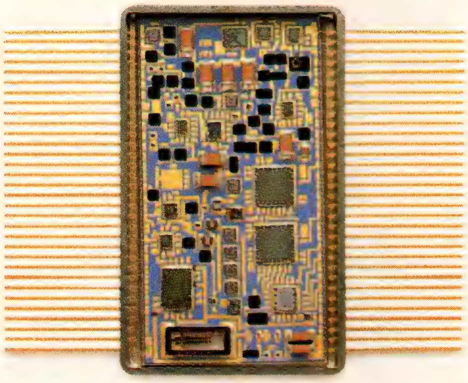
We also have sales and marketing centers in: **BENELUX** Brussels Tel: 02 733 9730 Tx: 22100 **ITALY** Milan Tel: (2) 390044/5 Tx: 331347 **FRANCE** Les Ulis Cedex Tel: (1) 64-46-23-45 Tx: 692858F **GERMANY (FDR)** Munich Tel: 089 23 62-0 Tx: 0522197

These are supported by agents and distributors in major countries worldwide.

# Concept

*Papilio palinurus*
*"Swallowtail"*
*enlarged 1.5×*

# Reality



*Circo Craft Chip & Wire*
*shown actual size*

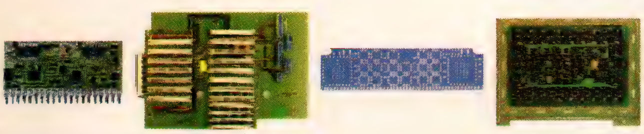
## Technology imitates nature

There's nothing quite like Nature. Or is there? At Circo Craft we advance technology with natural ingenuity and precision.

Three efficient facilities give us the edge in designing and manufacturing electronic packaging solutions to your requirements. Circo Craft specialties include:

- Chip and Wire Hybrid Microcircuits.
- Surface Mounts on Ceramics or Printed Circuit Boards.
- Back Panel Assemblies.
- Multilayer Printed Circuit Boards in volume.
- Sales Offices throughout U.S.A.

When you have an idea you hope will take wing, contact us and we'll provide all the technological support, naturally.



**circo craft**

205 Brunswick Blvd., Pointe-Claire, Quebec, Canada H9R 1A5
Telephone: (514) 694-8400

CIRCLE NO 165

# PAL devices: We didn't wait for the future.

There's no doubt that we're fast. But speed isn't all that makes us the logical choice in programmable logic.

AMD PAL* devices give you more because they have more functions per chip. With unique features like input/output logic macrocells, buried registers and variable product term distribution, you can design with more efficiency. And freedom.

## PAL devices you can count on.

Speed and functionality don't mean much if you can't count on your PAL devices. We can deliver better than 98% programming yield. And we added extra circuitry for functional and AC testing. That means we can test parts prior to programming. Then after you've programmed all the parts, you'll be pleasantly surprised to discover our Post-Programming Functional Yield is an incredible 99.9%.

Our products range from industry standard 20- and 24-pin PAL devices to the innovative 22V10. We've got the kinds of technologies and features you need in packages and temperature ranges to fit your design. We've even got high-complexity $E^2$CMOS products and ECL on the way.

And it's easy to use our PAL devices because we provide a broad selection of high level software that lets you get from system requirements to programmed product easily. Need more information? Just ask and we'll send you the AMD Programmable Logic Handbook.

Now you don't have to wait for the future either.

**Performance Speed-Up
20-Pin PAL Devices**

| Propagation Delay | Speed Level | Date |
|---|---|---|
| 25.0ns | A Speed | Q4, 1981 |
| 15.0ns | B Speed | Q3, 1986 |
| 10.0ns | D Speed | Q3, 1987 |
| 7.5ns | E Speed | Q4, 1987 |

*PAL is a registered trademark of, and is used under license from, Monolithic Memories Inc.

**Advanced Micro Devices**

P.O. Box 4, Westbury-on-Trym, Bristol BS9 3DS
United Kingdom.

*Bruxelles* (32-2) 771 91 42 • *Hannover* area (49-5143) 50 55
*Hong Kong* (852-3) 695377 • *London* area (44-4862) 22121
*Manchester* area (44-925) 828008 • *Milano* (39-2) 3533241
*München* (49-89) 41 14-0 • *Osaka* (81-6) 243-3250 • *Paris* (33-1) 49 75 10 10
*Seoul* (82-2) 784-7598 • *Stockholm* (46-8) 733 03 50 • *Stuttgart* (49-711) 62 33 77
*Taiwan* (886-2) 7122066 • *Tokyo* (81-3) 345-8241 • *Latin America, Fort Lauderdale, Florida/U.S.A.* Tel: (305) 484-8600 Tlx: (510) 955-4261 amd ftl

**CIRCLE NO 164**


# EVERYTHING YOU NEED FOR FIBER OPTIC INTERCONNECTIONS, INCLUDING LOWER INSTALLED COST.

**Thomas & Betts has the broadest selection of fiber optic interconnection components.** We're converting our technological expertise into Fiber Optic Interconnection quality-engineered products you can rely on for fast, easy connections at lower installed costs. Our rugged metal *SMA* connector design utilizes our in-field cleaving tool technology to allow polish and grind-free terminations. The system includes a passive coupler and an active coupler. Our precision capillary, Pre-Cap™ series of connectors, provided in ST* compatible, SMA and FC styles, offer high performance, low cost connectors in both cleave and polish versions. Our transceiver line includes our new RS-232C modem which provides flexible, cost-competitive solutions for hardwired data problems, using either glass or plastic fiber terminations. The board mounted *PCB Data Link* series allows fast terminations — no adhesives, polishing or special tools — for a high performance, cost-effective system. We offer complete, in-field *splice kits* for high quality, low-loss repair splices.

*Fiber Optic Cleaving Tool*

If you have a fiber optic interconnection problem, we have a dependable, cost-effective solution for both in-field and in-house applications. For design application assistance and more complete information, write or call Customer Service, Thomas & Betts Corporation, 920 Route 202, Raritan, NJ 08869; (201) 469-4000.

**Thomas&Betts**
*Electronics Division*

**Other quality Electronics Division products include:** *IDC Cable and Connector Systems, DIP and VLSI Sockets, Fiber Optic Systems, Flexible Interconnects, and Two-Piece Connectors.*

*A trademark of AT&T Technologies.

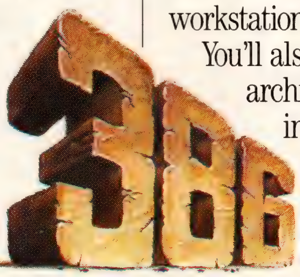

IF YOU'VE BEEN
WONDERING WHAT
DAISY'S BEEN
UP TO LATELY...

# WE'D LIKE TO BRING YOU UP TO SPEED.

**INTRODUCING THE PERSONAL LOGICIAN 386.™ AND A WHOLE LOT MORE.**

There's nothing in the world of CAE workstations that can bring your projects up to speed like Daisy's new PL 386.

With its 80386 engine running at a full 16MHz, you can fly through the toughest applications. Schematic capture. Analog and digital simulation. Test development. IC and PCB layout.



*The PL 386's 80386 engine lets you fly through the toughest applications.*

Just name it. With the PL 386 you'll get it done faster and better than with any other workstation in its class.

You'll also get AT architecture, the industry standard, used in more CAE workstations than Apollo, HP, Sun and DEC combined.

Anybody can build a bigger engine. The real trick is figuring out how to use all that power.

*Daisy's multi-tasking operating system lets you run a simulation in one window while you work on your schematic in another. So you won't get trapped.*

With the PL 386 we've turned power into performance.

Our DNIX™ operating system gives you multi-tasking, multi-window operation. You also get a choice of EGA or Daisy high resolution graphics. Along with mouse control, pop-up menus, icons and on-screen forms. All of which gets you into the driver's seat and up to speed in record time.

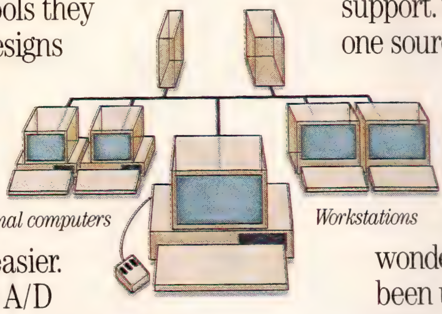
Want your workstation fully

integrated into a networked environment? No problem. We'll even take it a step further. With our Ethernet-based LAN, your PL 386 becomes part of a truly distributed environment—including PC/ATs, high performance accelerators, layout workstations and the Digital Microvax II.™ All sharing the same operating system, the same database, the same proven software.

So your engineering team gets all the tools they need to get your designs to market faster than ever.

We've even got some new applications to make your job easier. Like our exclusive A/D Lab, which lets you quickly simulate mixed analog/digital designs. STAR Router, for faster PCB routing. And several other packages designed to make short work of your toughest projects.


*With the PL 386 you can run the complete line of Daisy CAE applications. Plus a broad range of DOS programs.*




*The PL 386 is part of a complete CAE environment, including workstations and shared network resources.*

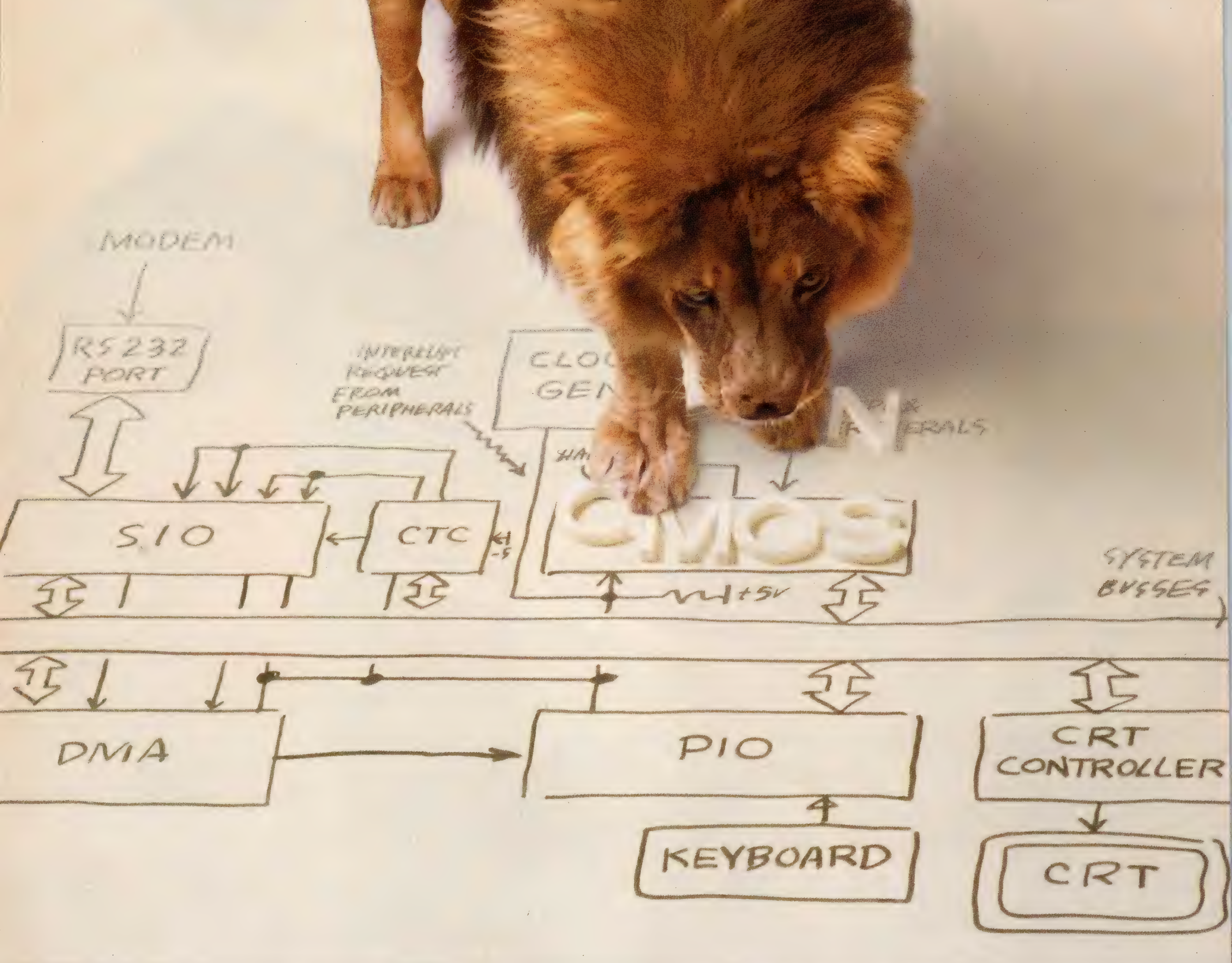
Of course, all this wonderful technology isn't worth much if it's not backed by strong support. With Daisy you get one source for technical assistance, training and hotline support. No one offers more.

So if you've been wondering what Daisy's been up to lately, relax. We've just been busy creating a new generation of CAE products to help you get your job done faster and better.

We'd like to tell you more. Give us a call. We'll bring you up to speed in no time at all. Call: 1 (800) 556-1234. In California: 1 (800) 441-2345, ask for Ext. 32. European Hdqtrs: (33) 1 45 37 00 12, Paris, France.

daisy SYSTEMS CORP.

# TOSHIBA CMOS




**ALABAMA,** Marshall Electronics Group, (205) 881-9235, Milgray Electronics, Inc., (404) 393-9666;**ARKANSAS,** Marshall Electronics Group, (214) 233-5200, Milgray Electronics, Inc., (214) 248-1603, Sterling Electronics-Dallas, (214) 243-1600; **ARIZONA,** Marshall Electronics Group, (602) 496-0290, Sterling Electronics-Phoenix, (602) 268-2121; **CALIFORNIA,** Image Electronics, (714) 259-0900, (818) 707-0911, Marshall Electronics Group, (818) 407-0101, (714) 458-5395, (408) 942-4600, (916) 635-9700, (619) 578-9600, Merit Electronics, Inc., (408) 434-0800, Ryno Electronics, (619) 453-8430, (714) 637-0200, Western Microtechnology, (408) 725-1660; **COLORADO,** Marshall Electronics Group, (303) 451-8383, Sterling Electronics-Denver, (303) 796-7338; **CONNECTICUT,** Cronin Electronics, Inc., (203) 265-3134, Marshall Electronics Group, (203) 265-3822, Sterling Electronics-Wallingford, (203) 265-9535; **DELAWARE,** General Components, Inc., (609) 768-6767, Marshall Electronics Group, (301) 840-9450, Milgray/Delaware Valley, Inc., (609) 983-5010, (800) 257-7808, (800) 257-7111, Sterling Electronics-Sterling, (703) 450-2373; **DISTRICT OF COLUMBIA,** Marshall Electronics Group, (301) 840-9450, Milgray/Washington, Inc., (301) 621-6169, (301) 621-8169, (800) 638-6656, Sterling Electronics-Sterling, (703) 450-2373; **FLORIDA,** Marshall Electronics Group, (305) 841-1878, (813) 576-1399, (305) 928-0661, Reptron, (813) 855-4656, (305) 735-1112; **GEORGIA,** Marshall Electronics Group, (404) 923-5750, Milgray Electronics, Inc., (404) 393-9666, Reptron, (404) 446-1300; **IDAHO,** Marshall Electronics Group, (801) 485-1551, Western Microtechnology, (503) 629-2082; **ILLINOIS,** GBL Goold Electronics, (312) 593-3220, Marshall Electronics Group, (312) 490-0155, Milgray Electronics, Inc., (913) 236-8800, (312) 350-0490; **INDIANA,** GBL Goold Electronics, (312) 593-3220, Marshall Electronics Group, (317) 297-0483, Milgray/Chicago, Inc., (312) 350-0490; **IOWA,** Dee Electronics, Inc., (319) 365-7551, (800) 332-5478, (800) 553-5421, Marshall Electronics Group, (612) 559-2211, Milgray Electronics, Inc., (913) 236-8800; **KANSAS,** Marshall Electronics Group, (913) 492-3121, Milgray Electronics, Inc., (913) 236-8800, Sterling Electronics-Kansas, (913) 236-5589; **KENTUCKY,** Marshall Electronics Group, (513) 236-8088, Milgray/Cleveland, Inc., (216) 447-1520, (800) 321-0006; **LOUISIANA,** Marshall Electronics Group, (214) 233-5200, Milgray Electronics, Inc., (214) 248-1603, Sterling Electronics-Dallas, (214) 243-1600; **MAINE,** Cronin Electronics, Inc., (617) 449-5000, Marshall Electronics Group, (617) 658-0810, Sterling Electronics-Boston, (617) 938-6200, Western Microtechnology, (617) 273-2800; **MARYLAND,** Marshall Electronics Group, (301) 840-9450, Milgray/Washington, Inc., (301) 621-8169, (301) 621-6169, (800) 638-6656, Sterling Electronics-Sterling, (703) 450-2373; **MASSACHUSETTS,** Cronin Electronics, Inc., (617) 449-5000, Marshall Electronics Group, (617) 658-0810, Sterling Electronics-Boston, (617) 938-6200, Western Microtechnology, (617) 273-2800; **MICHIGAN,** Calder Electronics, (616) 698-7400, Marshall Electronics Group, (313) 525-5850, Semiconductor Reliability Assoc., Inc., (313) 965-8550; **MINNESOTA,** Marshall Electronics Group, (612) 559-2211, Reptron Electronics, (612) 938-0000; **MISSISSIPPI,** Marshall Electronics Group, (205) 881-9235, Milgray Electronics, Inc., (404) 393-9666; **MISSOURI,** Marshall Electronics Group, (913) 492-3121, Milgray Electronics, Inc., (913) 236-8800, Sterling Electronics-Kansas, (913) 236-5589; **NEBRASKA,** Marshall Electronics

# If at First* You Succeed, Succeed Again

*Available now—a new IEEE 488 Interface for the IBM Personal System/2 Models 50, 60 and 80.*

Ziatech's new ZT/2 interface and installable driver software enable the IBM PS/2 to control IEEE 488 devices like this spectrum analyzer.

## The ZT/2 from Ziatech Corporation

### Personal Work Stations

Ziatech's new ZT/2 makes the IBM PS/2 a personal instrumentation work station, with each interface connecting to up to 15 IEEE 488 devices.

### Software Support/Too

Ziatech's software driver choices make interfacing PS/2 test and measurement systems easy. Our installable drivers let you upgrade existing IBM and National Instrument IEEE 488 applications to the ZT/2 with minimal effort. Our linkable drivers connect your application directly to the ZT/2 for fast data transfers. Both drivers allow the ZT/2 to act as a controller or talker/listener. **And you only buy a Ziatech driver once—no recurring license fee to customers copying our drivers for multiple systems.**

**Ziatech developed the first IEEE 488 interface for the IBM PC, the Apple II, and for MULTIBUS and STD Bus systems.*

### Documentation and Application Assistance

Ziatech offers the best documentation in the business. And on-line applications engineers are ready to help you succeed. Because we want you to succeed. Again and again and again.

ZIATECH CORPORATION

*IEEE 488 Originals*

3433 Roberto Court
San Luis Obispo, CA 93401
805/541-0488
ITT Telex: 4992316
Fax: 805/541-5088

# NEWS BREAKS

EDITED BY JOAN MORROW

## CLOCK CHIP PROVIDES 20:1 COMPONENT COUNT REDUCTION

Eliminating 19 components from the assembly of IBM PC/AT- and PS/2-compatible computers, the DS1287 real-time clock offers pin-compatible replacement of the MC146818A chip currently used for PC timekeeping functions. Developed by Dallas Semiconductor (Dallas, TX, (214) 450-0400), the DS1287 contains a lithium power source to provide nonvolatile operation for more than 12 years in the absence of power. Calibrated for accuracy within one minute per month, the DS1287 corrects for Daylight Savings Time, provides leap-year compensation, and offers either 24- or 12-hour timekeeping with AM and PM notations. The chip sells for $10 (10,000).—J D Mosley

## SINGLE-BOARD COMPUTER FAMILY FEATURES TAILORED BASIC

Three single-board computers from Octagon Systems Corp (Westminster, CO, (303) 426-8540) feature CAMBasic, an onboard, ROM-based Basic specifically designed for control applications. This customized, multitasking language devotes 37 of its 144 commands and functions to performing low-level I/O tasks and manipulating the resulting data. The three computers in the family (the SBS-1000, SBS-1100, and SBS-1200) have other features in common, including a 32-bit parallel I/O port, dual serial ports, and a keyboard and display port. In addition, the $495 SBS-1000 includes a 4-channel analog multiplexer and a 12-bit integrating A/D converter. The $495 SBS-1100 has an 8-channel multiplexer and a 10-bit successive-approximation ADC. The SBS-1200 costs $445.—Steven H Leibson

## CMOS FLOATING-POINT DSP CHIP FEATURES 80-nSEC CYCLE TIME

Targeted at high-performance applications such as graphics, telecommunications, image processing, and speech processing, the AT&T (Allentown, PA, (800) 372-2447) WE DSP32C CMOS floating-point digital signal processor features cycle times as fast as 80 nsec. The processor is compatible with the IEEE standard floating-point number format, and you can purchase an optimized C compiler for software development. Other features include 15 general-purpose registers, five increment registers, two external interrupts, eight vectored interrupts, and a 16M-byte address space. It can fetch two 32-bit numbers from memory, multiply and accumulate the result, and write the result to memory in one 80-nsec instruction cycle (25M flops). Expect samples to be available at the end of the year; production quantities will be shipped in the 1st qtr of '88. The $70 (10,000) device will be packaged in a 133-pin PGA.—Maury Wright

## SINGLE-CHIP LOGIC ANALYZER BUILDS RANGE OF INSTRUMENTS

A logic-analyzer-on-a-chip IC serves as the basic building block for three logic analyzers from Hewlett-Packard Co (Palo Alto, CA). The proprietary chip implements 16 channels worth of state analyzer, timing analyzer, and acquisition memory with 144,000 transistors. The company used two of these devices in its 80-channel, $7800 HP1650A and five of the devices in its 32-channel, $3900 HP1651A general-purpose logic analyzers. These instruments feature 100-MHz timing analysis, 25-MHz state analysis, a 1k-bit/channel memory depth, and an integral floppy-disk drive to store setups and test results.

Five of these analyzer ICs found their way into the $5200 HP16510 logic-analysis module (essentially an HP1650A on a card) that plugs into the company's $7200 HP16500A logic-analysis system mainframe, which features a color CRT display, touch-screen or mouse-driven user interface, and dual floppy-disk drives. The mainframe accepts five modules, so you can build a 400-channel logic analyzer.—Steven H Leibson

# NEWS BREAKS

## ECL GATE ARRAYS SUIT HIGH-PERFORMANCE APPLICATIONS

Texas Instruments (Dallas, TX, (800) 232-3200) and Motorola Inc (Phoenix, AZ, (602) 821-4426) recently introduced enhanced ECL gate arrays in a quest for the high-speed ASIC market. TI's TGE8000 array incorporates 896 internal cells providing a maximum equivalent gate count of 8584 gates. The device is packaged in a 149-pin pin-grid array and supports a maximum of 120 I/O pins with as many as 72 outputs. Its output drivers will drive 50 and 25Ω signal lines. The company fabricates the array with its new ExCL process that achieves maximum internal propagation delays of 200 psec and output driver delays of 600 psec. This product is currently at beta sites. Production is scheduled for the 4th qtr of this year. The company expects initial cycle times—from design release to prototype parts—of eight to 10 weeks and plans to reduce this time to 30 days by the first half of 1988. NRE charges range from $40,000 to $70,000, and the parts cost approximately $300 (1000).

Although it features only 1708 equivalent logic gates in 131 cells, Motorola's MCA1500M array also includes 1152 bits of 5-nsec max RAM organized as four blocks of 32×9 bits. The device offers some flexibility in RAM organization, with single-ported designs ranging from 32×9- to 256×4-bit arrays and dual-ported designs ranging from 32×9- to 128×4-bit arrays. Internal gate delays are 300 psec typ, and output driver delays are 750 psec typ. The part has 120 I/O cells and can support as many as 64 outputs, 55 of which can drive 25Ω loads. (All outputs can drive 50Ω loads.) Cycle time is currently seven weeks, and typical NRE charges are approximately $37,000. In a 149-pin PGA, the part costs $195 (1000).—Steven H Leibson

## OPEN-ARCHITECTURE IMAGING SYSTEM HAS 160-MIPS CAPABILITY

If you have a high-speed image-processing application but don't want to restrict yourself to a dedicated imaging workstation, consider the $88,000 Model 120 Vitec Image Computing System from Visual Information Technologies Inc (Plano, TX, (214) 596-5600). This open-architecture VME Bus system uses a custom VLSI image-processing chip set to achieve processing speeds reaching 160 MIPS for manipulating text, graphics, and photographic-quality pictures. The Model 120 combines its 16.67-MHz 68020 CPU with an image memory manager, algorithm processor, and a parallel image processor to provide you with a complete plug-and-play imaging system in an integrated desk-side unit. And you can use standard software such as Unix BDS 4.2, MIT's X-Window, DEC and HP graphics-software development tools, and the C programming language.

The Model 120 comes with a 68881 floating-point coprocessor, 4M bytes of RAM, 10M bytes of image memory, a 140M-byte hard-disk drive, a 19-in. color monitor, a 60M-byte tape drive, six VME Bus slots, an Ethernet interface, a keyboard, a mouse, and a Unix license. An application development software package costs $4995 and includes X-Windows, IDLS, a primitive module of image/graphics algorithms, and a set of image-oriented window and menu tools.—J D Mosley

## SYMBOLIC DEBUGGER FOR EMULATORS FREES HOST COMPUTER

If you use HMI-200 Series in-circuit emulators from Huntsville Microsystems Inc (Huntsville, AL, (205) 881-6005), you can now order an optional symbolic debugger with 256k bytes of symbol memory for $1000. The HMI-200 Series provides emulation for Z80, 68000, and 64180 μPs, and the optional debugger lets you download symbols from your host to the emulator, thus freeing your host computer during the debugging operation and offloading the debug session to your emulator. A pass-through mode on the emulator lets you switch your terminal's monitoring capability between operation with the emulator and your host computer.—J D Mosley

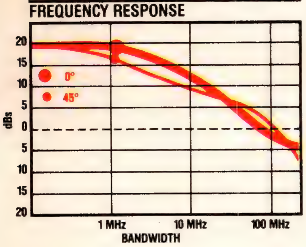
# NOW, MORE PRECISION IN 6GHz LINEAR.

## HERE'S OUR LATEST SOLUTION FOR YOUR HIGH-PERFORMANCE ANALOG SYSTEM.

Introducing the *VA701/VA711 Low-Noise, Precision Op Amps* . . . the newest members of our highly successful VA700 Op Amp Family.

These op amps have DC performance parameters similar to the industry-standard OP-27, but with extended AC performance, optimized for ±5V power supplies.

FREQUENCY RESPONSE




Output voltage swing is typically ±4V, with input common mode range ±3.5V.

The VA700 Family is just part of VTC's broad line of Linear Signal Processing (LSP) ICs. This line gives you a whole range of analog solutions, for signal conditioning, data acquisition/conversion, signal transmission, and special functions.

Our LSP line includes *Op Amps* to 500 MHz bandwidth . . . precision, high-speed, and fast setting, plus duals and quads . . . with no sacrifice in performance.

*A/D Converters* to 12 bits, 1 µsec conversion.

*Flash Converters* to 8 bits, 250MHz.

*DACs* to 12 bits, 100 µsec settling time.

A family of ECL and TTL *High-Speed Comparators* to 1.5GHz.

*Video Amps* and *Unity Gain Amps* to 2000V/µsec, 300MHz.

And *Operational Transconductance Amplifiers* to 50V/µsec, 75MHz.

If your analog application requires high speed, high slew rate, low offsets, large power bandwidth, high output drive capability, fast conversion rates, and/or higher packaging density . . . then you should be specifying VTC's high-performance LSP ICs in your system!

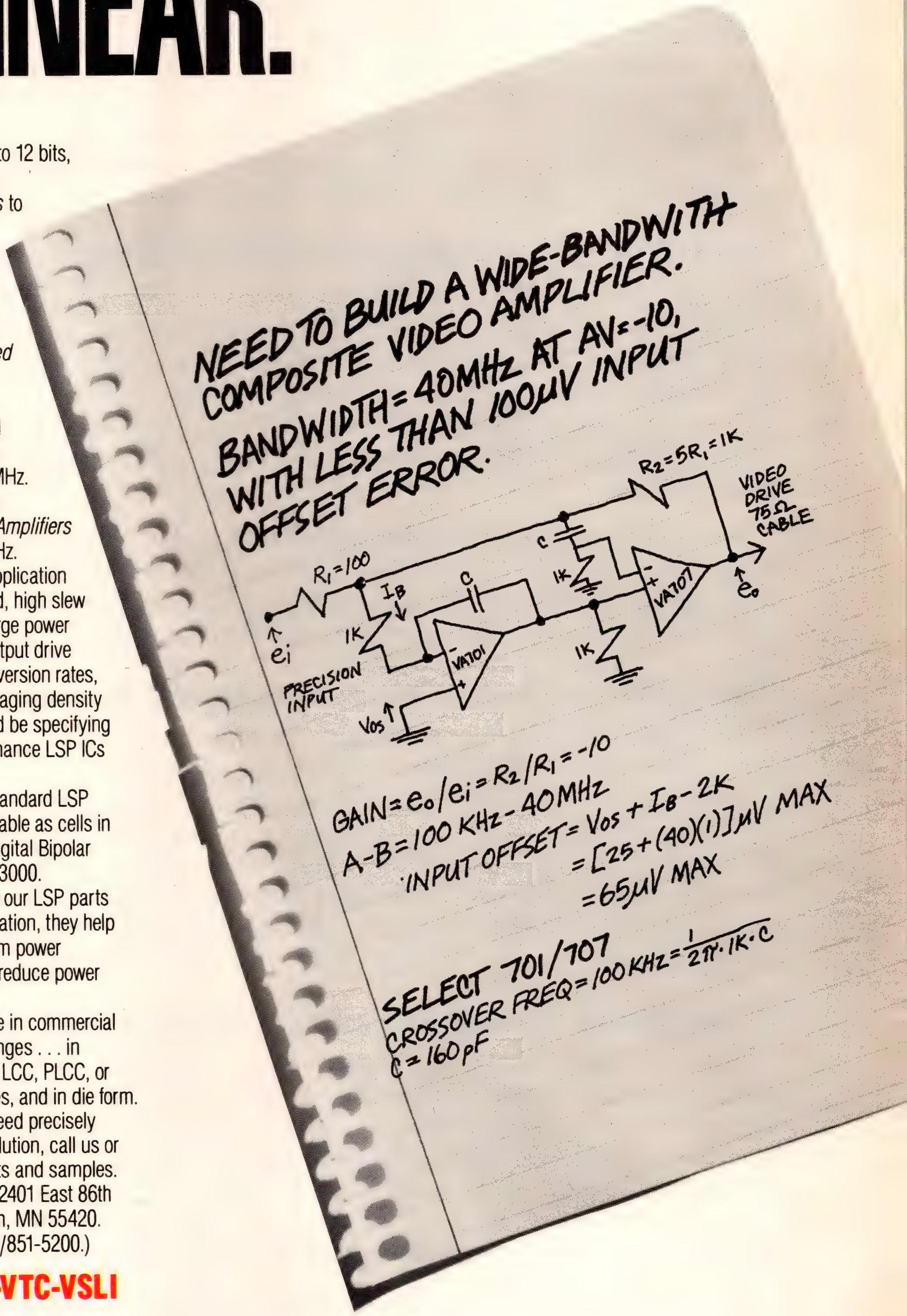
Most of these standard LSP parts are also available as cells in our 6GHz Linear/Digital Bipolar Cell Library, the VL3000.

And because all our LSP parts feature ±5V operation, they help simplify your system power requirements, and reduce power consumption.

They're available in commercial or military temp ranges . . . in cerdip, PDIP, SOIC, LCC, PLCC, or metal can packages, and in die form.

So, when you need precisely the right analog solution, call us or write for data sheets and samples. VTC Incorporated, 2401 East 86th Street, Bloomington, MN 55420. (In Minnesota: 612/851-5200.)

**CALL 1-800-VTC-VSLI**




**VTC Incorporated**
Performance, Pure & Simple.™

CIRCLE NO 160

# NEWS BREAKS: INTERNATIONAL

## PC-BASED EMULATORS PROVIDE HIGH-LEVEL-LANGUAGE DEBUGGING

Using the KSE4 Series of IBM PC/AT add-on in-circuit emulators, you can debug code written for 16-bit 68000- and 8086-family μPs, either at assembly-language level or at its C or Pascal source-code level. User-definable screen windows, which are dynamically updated, allow you to simultaneously display assembly-language and high-level-language information as you debug the program. You can switch between assembly-level and high-level-language debugging at will. The emulators, from Kontron Electronics (Eching, West Germany, TLX 526719; in the US, Mountain View, CA, (415) 965-7020) include four hardware breakpoints; you can also install as much as 2M bytes of emulation memory and a 64-channel, 8k-word trace analyzer. KSE4 emulator prices start at around DM 18,000.—Peter Harold

## REAL-TIME OPERATING-SYSTEM KERNEL REQUIRES NO LICENSING

For no additional charge, all 68020-based CPU cards from Force Computers (Ottobrunn, West Germany, TLX 524190; in the US, Los Gatos, CA, (408) 354-3410) are now being shipped complete with VMEPROM—an EPROM-resident, real-time operating-system kernel based on Eyring Research's PDOS operating system. The multitasking VMEPROM includes the PDOS kernel, file manager, and BIOS modules, plus a debug monitor, screen editor, disk-formatting utilities, and a terminal-based user interface.

By the end of this year, VMEPROM will be enhanced for use in multiprocessor systems. It will also be ported to the company's CPU-4, CPU-5, and CPU-6 16-bit CPU cards. For around DM 350, you can buy the firmware EPROMs and supporting documentation to upgrade existing CPU cards.—Peter Harold

## ENHANCED DMA CONTROLLER SUPPORTS 32-BIT DATA TRANSFERS

Siemens (Munich, West Germany, TLX 5210025; in the US, Iselin, NJ, (201) 321-3400) has introduced an enhanced version of its SAB82258 4-channel DMA controller, which supports 32-bit data transfers. Designated the SAB82258A, the new version contains additional logic to increment or decrement its memory addresses and byte counters by four. Using the SAB82258A to implement single-cycle 32-bit DMA data transfers eliminates as many as six external PAL devices, which were required to adapt the 16-bit SAB82258 DMA controller for 32-bit operation. By 1988 the 8-MHz version of the SAB82258A is expected to sell for around DM 90 (1000).—Peter Harold

## US SOFTWARE PACKAGES FIND DISTRIBUTION IN JAPAN

Two US software manufacturers—Laboratory Technologies Corp (Wilmington, MA) and Gateway Design Automation Corp (Westford, MA)—have announced distribution agreements with Japanese companies. Laboratory Technologies Corp's software licensing and resale agreement with Control Technology Ltd (Osaka, Japan) will bring Labtech Notebook—PC software for data acquisition and industrial process control—to Japanese engineers. Control Technology will translate the program and documentation into Japanese and resell it for the NEC 9800 Series microcomputers.

Gateway Design Automation Corp has signed a 2-year distribution agreement with SC Hightech Center Corp (a subsidiary of Sumitomo Corp in Tokyo), which allows SC Hightech to sublicense all Gateway products. Some of this software includes Verilog-XL for logic simulation; TestGrade, TestGrade-A, StatGrade, and BitGrade for fault simulation; and TestScan for test generation. Gateway software runs on a variety of hardware, including systems from IBM, DEC, Apollo, and Sun.—Joan Morrow

3 8
3 8
3 8 7 5 1
7 5 1
7 5 1
CLICK
Listen to assembly costs drop.
Sub-subminiature pushwheel switches snap together... mount to PC boards. No hardware. No hand wiring. Each one digit segment is only 6 mm wide. Ask for the specs. You'll like 'em.
CHERRY
CHERRY ELECTRICAL PRODUCTS
3600 Sunset Avenue, Waukegan, IL 60087 • (312) 360-3500
Actual size
Series T59
Switches • Automotive Devices • Electronic Components • Displays • Printed Circuit Boards • ICs • Keyboards
CIRCLE NO 159

# tough attenuators

## one-piece design defies rough handling from $11.95 (1-49)

- Each unit undergoes high-impact shock test
- Unexcelled temperature stability, .002 dB/°C
- 2W max. input power (SMA is 0.5W)
- BNC, SMA, N and TNC models
- Immediate delivery, one-year guarantee
- **50 ohms, dB values,** 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 30, and 40
- **75 ohms dB values,** 3, 6, 10, 15, 20 BNC only
- **Price** (1-49 qty.)
  CAT (BNC) $11.95 SAT (SMA) $14.95
  TAT (TNC) $12.95 NAT (N) $15.95

| *Freq. (MHz) | Atten. Tol. (Typ.) | Atten. Change, (Typ.) over Freq. Range | | VSWR (Max.) | |
|---|---|---|---|---|---|
| | | DC-1000 | 1000-1500 | DC-1000 MHz | 1000-1500 MHz |
| DC-1500 MHz | ±0.3 | 0.6 | 0.8 | 1.3 | 1.5 |

*DC-1000 MHz (all 75 ohm or 30 dB models) DC-500 MHz (all 40 dB models)

Model Availability

SAT (SMA) CAT (BNC) NAT (N) TAT (TNC)

Model no. = a series suffix and dash number of attenuation.
Example: CAT-3 is CAT series, 3 dB attenuation.

**Precision 50 ohm terminations** only $6.95 (1-24)
DC to 2 GHz, 0.25W power rating, VSWR less than 1.1
BNC (model BTRM-50), TNC (model TTRM-50)
SMA (model STRM-50), N (model NTRM-50)

finding new ways ...
setting higher standards

**Mini-Circuits**

A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Fax (718) 332-4661 Domestic and International Telexes: 6852844 or 620156

C 92 REV. C



CIRCLE NO 157

turn engineering ideas into finished printed-circuit boards quickly. And gives you the assurance that boards will match the approved design from engineering and be practical to manufacture.

You get a link from schematic capture to PCB design for highest design integrity, and system features that optimize designs for your actual manufacturing environment. The result is reduced manufacturing costs, higher yield, and improved reliability.

You can also transfer netlist and part information from PCB design to HP's board test system, ending manual-entry hassles and errors.

## HP DesignCenter: our commitment to CAE/CAD

HP's CAE/CAD tools are part of HP DesignCenter . . . a powerful product development environment that unites the activities of electronic, mechanical, and software engineers through integrated systems, software, and support.

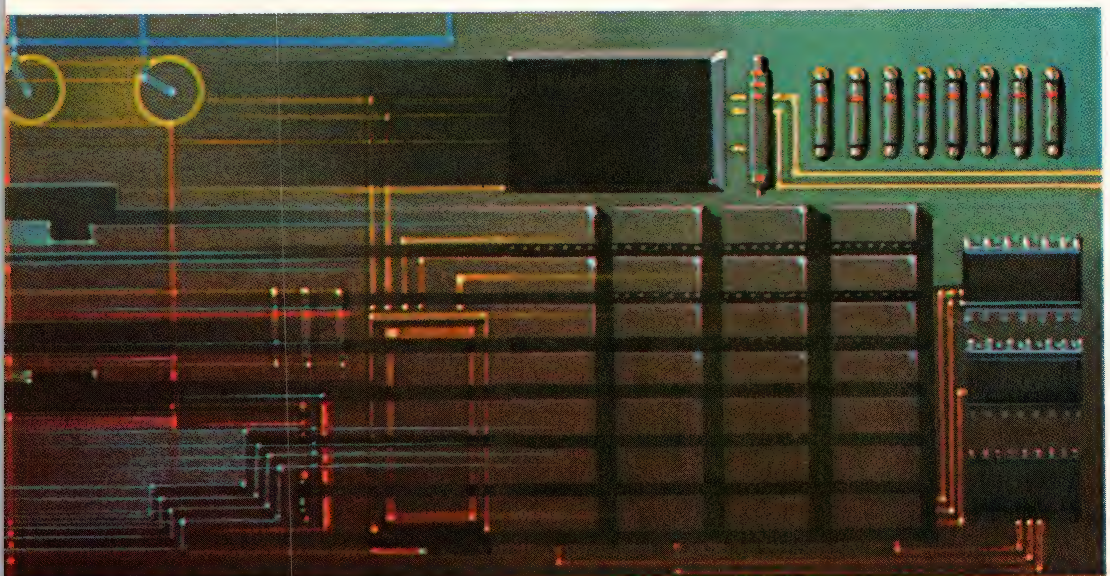
For all the facts, call your local HP sales office listed in the telephone directory white pages. Or call 1-800-447-3282 (in Colorado call 590-5540 collect) for free literature on our CAE/CAD solutions.

HEWLETT PACKARD

we never stop asking

"What if..."

# development test.



▷▷▷▷▷▷▷▷▷▷▷▷▷▷▷▷▷▷ to finished product faster

DS15611A



CIRCLE NO 156

## Layoffs pose serious problems for engineers

I'd like to comment on the letter from Wendy Alexandar, which appeared in the May 28 issue of EDN (pg 32).

Ms Alexandar is right on one point only: the fact that as an engineer, her salary is more than twice her husband's salary.

First, however, nothing forces her husband to stay with a nonprofit foundation or social-service organization, no matter how useful and needed it is, unless the social work is more important to him than income is.

Second, Ms Alexandar missed the point about layoffs. Sure, engineers don't have a monopoly on layoffs, but as a general rule, unlike the steel and auto workers she mentioned, engineers do not have a union that provides for layoff indemnities, and engineers are almost never recalled. Thus, a laid-off engineer has to hunt for another position while getting skimpy state unemployment compensation (which is $90 maximum in Indiana, and some states are even worse).

Personally, I am sick and tired of being laid off in spite of my broad qualifications, valuable experience, and outstanding accomplishments. I've been laid off nine times in 29 years; eight of those layoffs happened under Republican administrations.

Engineers are forced to jump from company to company—first with each layoff, then between layoffs in the attempt to beat management to the draw, to get recognition, or just to keep up with the cost of living. Many companies are laying off experienced engineers while hiring young graduates at much lower salaries; experience is valued but isn't paid for.

You can imagine the family disturbances caused by this state of affairs: relocation in most cases, selling and buying houses, moving into areas that have a higher cost of living, putting children into different schools, etc. All of this destroys family and marriage, which are the basic cells of our society.

Worse yet, at age 60 I do not have a vested interest in any company retirement plan. I think engineers need to unite for a mobile retirement system.

To add insult to injury, very often new engineering positions turn out to be quite different than they seem during interviews. My talents as an experienced microwave designer (to 40 GHz) are supposedly in short supply. Yet with several employers I found myself wasted as much as 90% of the time—lining up at the copying machine, typing my own memos, shuffling useless stacks of paper, or

Text continued on pg 34

# MIL-M-38510.

4SS-5139R5

# SPRAGUE IS CERTIFIED FOR POWER ICs.

Sprague Power Integrated Circuits are processed on a DESC certified production line to MIL-M-38510. QPL and compliant devices are screened to Class B assurance levels of MIL-STD-883C. These high-voltage and high-current power ICs provide excellent answers as peripheral power drivers for displays, motors, solenoids, relays, printers, and heaters. Long recognized as *the* leader in power ICs, Sprague will continue to supply selected components on the Qualified Parts List.

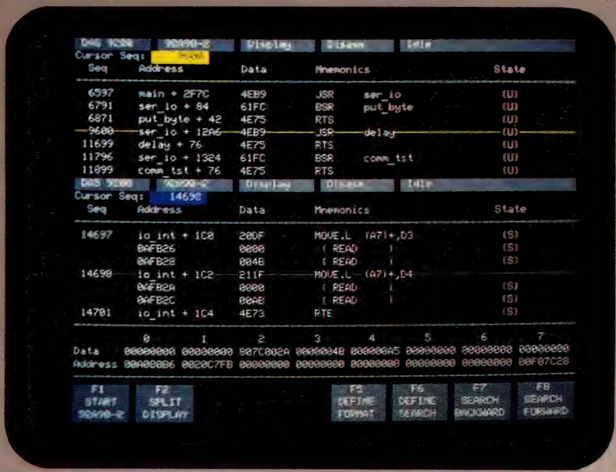
*Sprague Electric Company, Semiconductor Group, Worcester, MA.* For applications assistance, call 800/247-2077 (in Mass., 800/247-2076). For Brochures WR-192 and WR-198, write to Technical Literature Service, Sprague Electric Company, P.O. Box 9102, Mansfield, MA 02048-9102.

SPRAGUE
THE MARK OF RELIABILITY

**CIRCLE NO 155**

# DAS9200 DIGITAL ANALYSIS: NOW TEK MAKES THE IMPOSSIBLE LOOK EASY.


Software Performance Analysis, like this distribution of a subroutine's execution times, helps you easily understand the activity of your code.




Step backwards through acquired data, including subroutines, stack and register models, using time-correlated split-screen displays to pinpoint problems.

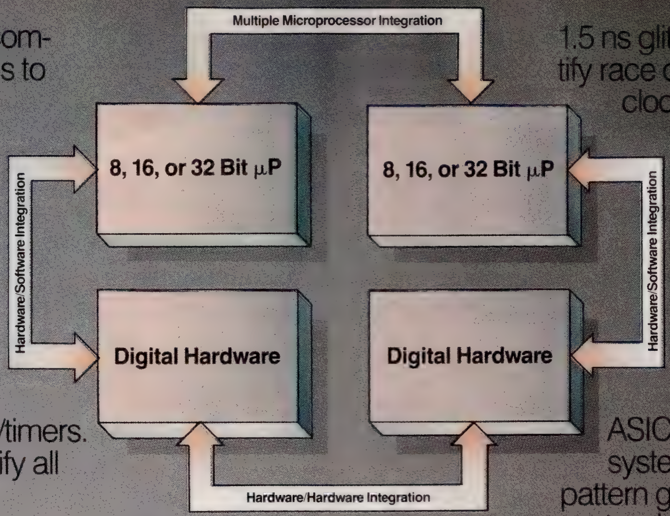
**In every dimension—speed, channel width, memory depth, trigger capability, modularity and ease of use—the DAS9200 dwarfs what's been possible before.**

The DAS9200 features a tightly coupled, high-speed architecture in which multiple card modules can act as a single unit. Large color-coded displays, pop-up menus, performance analysis graphs,

multi-tasking and more combine to take logic analysis to levels like these:

**1 State-driven triggering at 200 MHz.** You can use up to 384 channels of sync and async data acquisition. You can assurance-test high-speed logic at full speed, using 4-level state tracking and high-speed counter/timers. You can monitor and verify all timing measurements in a circuit.

**2 Symbolic, real-time software debugging.** Register deduction and stack simulation let you pinpoint problems like stack overflow or incorrectly restored pointers—without breakpoints or manual notation.

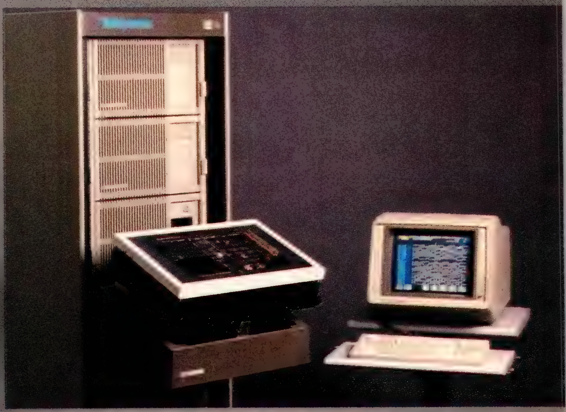



**3 Simultaneous integration of up to six microprocessors.** Use the dual timebases and real-time handshaking between system modules to set up split-screens displays that scroll in precise time alignment.

**4 160 channels of acquisition at 2 GHz.** Use up to 500 ps sample interval and 1.5 ns glitch detection to identify race conditions, spurious clocks and setup/hold violations in any logic family. System probes feature input capacitance of <1 pf.

**5 Easy ASIC verification at up to 50 MHz.** The DAS9200 is available as a low-cost turnkey ASIC device verification system. Featuring 50 MHz pattern generation, 8K bit vector depth, and 1 ns edge placement, it offers the power, precision and simplicity to be an attractive alternative to centralized systems.

**6 Stop wishing for the impossible in digital analysis:** Compare your wish list against the complete list of DAS9200 capabilities. Contact your Tek sales engineer, or call toll-free for more information. **Call 1-800-245-2036.** In Oregon, 231-1220.



Available in desktop and rack-mount versions, the DAS9200 mainframe can be augmented with up to three expansion mainframes for a total of 28 card slots.

**Tektronix®**
COMMITTED TO EXCELLENCE

Circle 154 for literature

Circle 193 for sales call

hunting for hours for the proper charge number to put on a timecard so that my employer could charge a fat fee for my wasted time to a government contract.

This profession could be a good, challenging, fascinating one, but with the present state of affairs, I sure would not advise a son of mine —or anybody, for that matter—to choose the engineering field.
*Name withheld upon request*

## Chip price is misleading

In his letter in EDN's May 14 issue (pg 32), Cylink President/CEO Lewis C Morris is the one who's misleading, not EDN, when he states that his company's CY1024 chip costs less than $100 in OEM quantity. Our company wrote to his to obtain some of his $100 CY1024 ICs, and we got a letter back telling us the parts would cost $1500 per chip. If his letter is not misleading, I don't know what is. To use those chips at just two distant locations would add $3000 to the cost of a circuit. Who's kidding whom?

We thought $100 was outlandish; $25 would be more like it. Gold is cheaper than this silicon.
*L J Paul, CDP*
*President*
*Telephone Enterprises*
*Thousand Oaks, CA*

*(Ed Note: We agree with L J Paul that the $100 OEM price is misleading. According to Cylink's April 1986 price list for the CY1024 processor chip, you get the chips at the $100 price* after *buying 6660 chips at an average cost of approximately $184 each.)*

## Design Idea notes

The Design Idea entitled "Second µP enhances TMS32020 system" (EDN, April 30, pg 230) was contributed by Luis Vieira de Sà *and* Fernando Perdigão, both of the Universidade de Coimbra, Coimbra, Portugal.

L J Francz of Dialogic Inc (Parsippany, NJ) points out an error in **Fig 2** of the Design Idea "Two-way amplifier uses few parts" (EDN, February 19, pg 204): The denominator in Note 3 should read $R_D - R_B$ (not $R_B + R_D$).

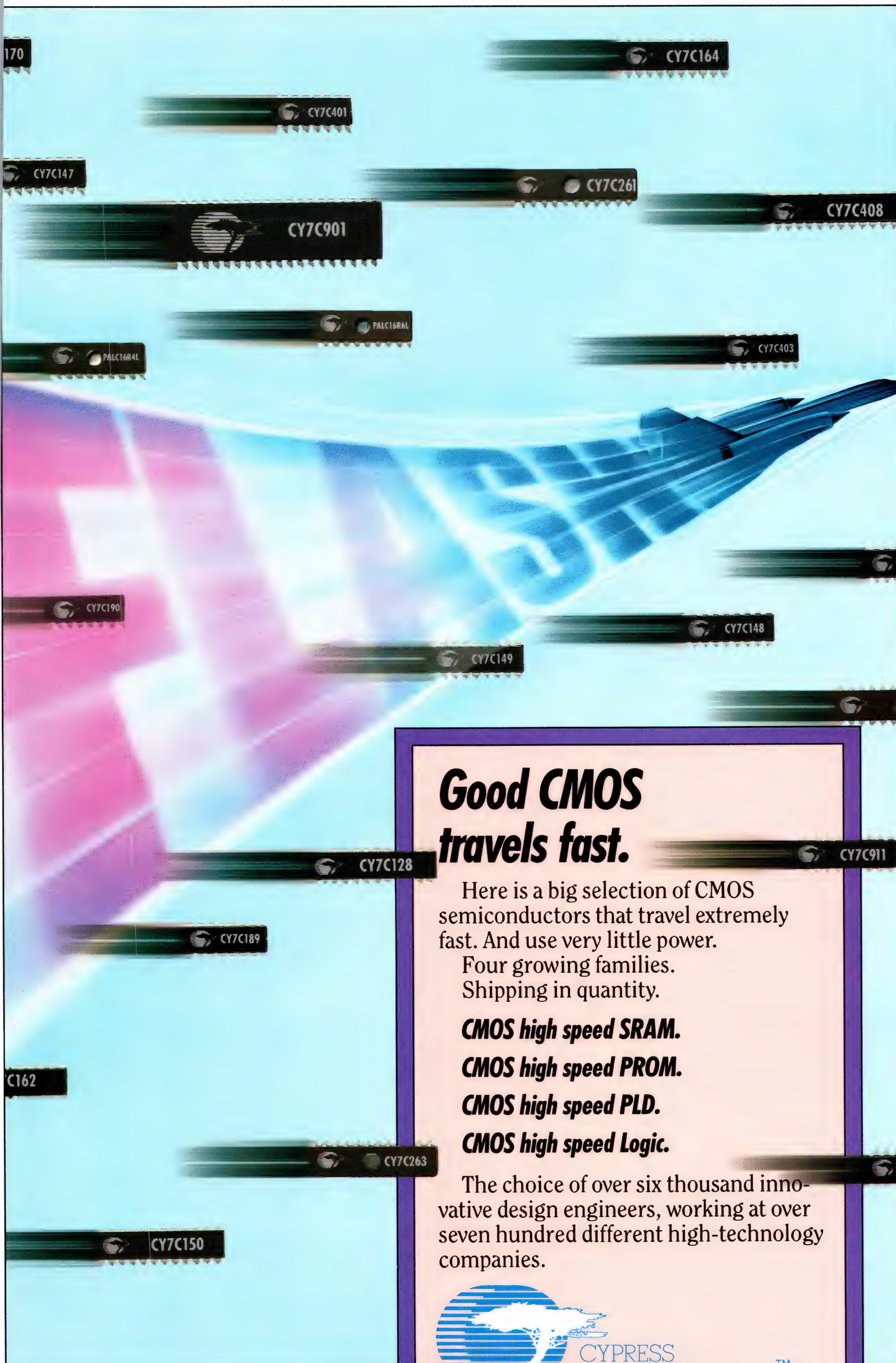
### YOUR TURN

EDN's Signals and Noise column provides a forum for readers to express their opinions on issues raised in the magazine's articles or on any topic that affects the engineering industry. Send your letters to the Signals and Noise Editor, 275 Washington St, Newton, MA 02158. We welcome all comments, pro or con. All letters must be signed, but we will withhold your name upon request. We reserve the right to edit letters for space and clarity.





CIRCLE NO 5




# Good CMOS travels fast.

Here is a big selection of CMOS semiconductors that travel extremely fast. And use very little power.

Four growing families.

Shipping in quantity.

***CMOS high speed SRAM.***

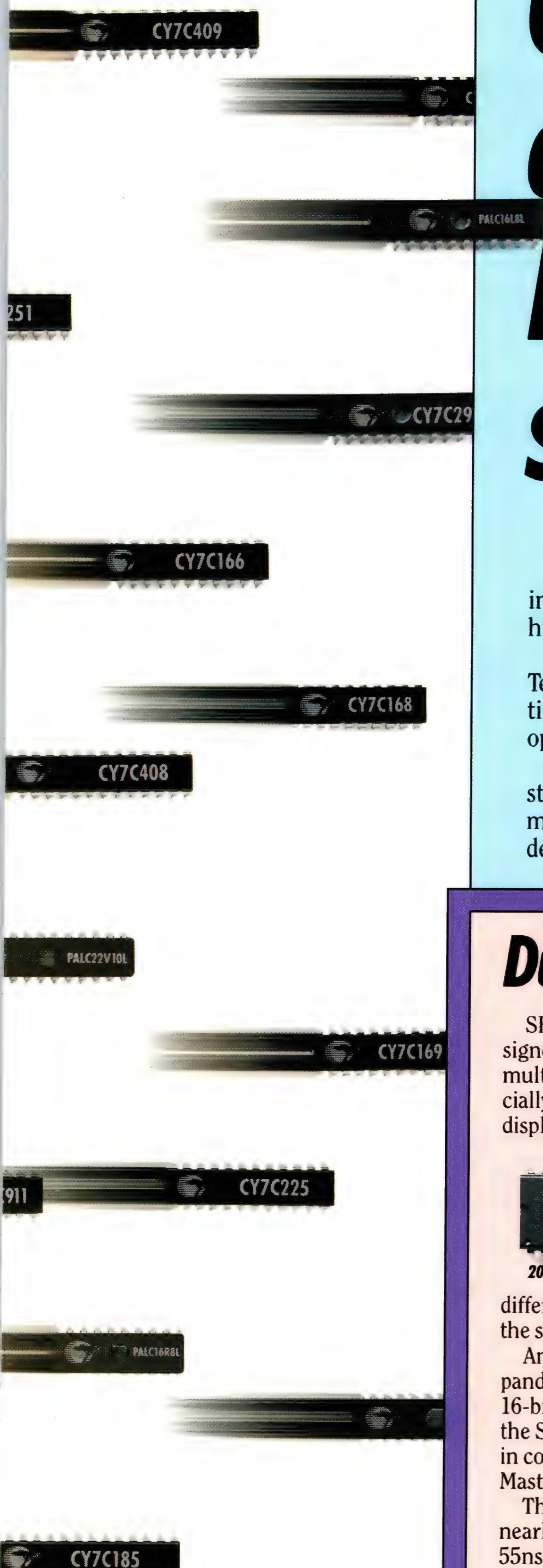
***CMOS high speed PROM.***

***CMOS high speed PLD.***

***CMOS high speed Logic.***

The choice of over six thousand innovative design engineers, working at over seven hundred different high-technology companies.

CYPRESS SEMICONDUCTOR™




# Good news for al of you who desig high performanc systems:

Our 0.8 micron fab process in California is moving into high gear.

And we're bringing up our new Texas fab facility, which is many times larger than our California operation.

As that capacity comes on stream it will ultimately yield a manifold increase in our ability to deliver the CMOS semiconductors you need for highest performance systems. Systems that use less power, and require less space.

And that is good news.

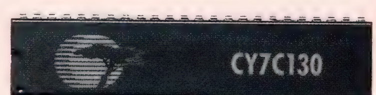
But our demanding customers want to know more.

They ask us how we can increase capacity and still maintain our proven high quality levels.

Here is our program:

## Dual Port SRAM: 35ns!

SRAM for system designers (in areas like DSP, multiprocessors, and especially high performance displays) that lets two different systems access the same memory area.




1024x8 Dual Port Static RAM 35ns


2048x8 Dual Port Static RAM 35ns


1024x8 Dual Port Slave Static RAM 35ns


2048x8 Dual Port Slave Static RAM 35ns

And you can easily expand the data bus width to 16-bits or more by using the Slave Static RAM parts in conjunction with the Master devices.

These 35ns parts are nearly 40% faster than 55ns alternatives.

And their architecture minimizes delays due to conflicts—both memory systems trying to access the same location. How? Unlike architectures that control conflict by restricting access to blocks, or even to the entire part, Cypress reduces the potential area of conflict to a single memory address location.

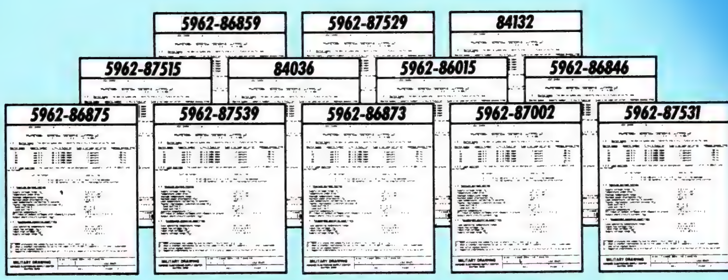
Automatic power-down keeps power consumption to a minimum. And, for reliability, you have the assurance that all Cypress Semiconductor SRAMs are capable of withstanding a minimum of 2001 Volts ESD.

# Good news for military customers who need highest performance CMOS:

Our commitment to your design-in needs is making it easier and easier to design in our high performance circuits.

Our facility is DESC certified. And we have our first JAN qualified part, our JM38510/28901 4K SRAM. At 35ns, it is the fastest JAN 4K Static RAM available.


**4Kx1 SRAM 35 ns.**




*Twelve drawing numbers moving through the DESC approval channel.*

***But the biggest news is our SMD (Standard Military Drawing) program.***

We actively support the military push for standardization. And we're actively supporting the DESC-sponsored SMD program.

As a result, we're building the capability to draft Standard Military Drawings quickly and efficiently.

That capability is paying off. We have twelve products certified or pending certification, with many, many more scheduled in the near future.

And we intend to see that they become JAN slash sheets as quickly as possible.

Our growing list of SMD parts means you can take advantage of the enhanced quality rating (MIL-HBK-217) of SMD product more and more, as you design with Cypress products.

Is it important to you to have a certain part available under the SMD program? You won't find a more cooperative or better equipped vendor to help you than Cypress Semiconductor.

***Military quality is not a sideline at Cypress.***

Our automated U.S. plants were designed to pass the stringent JAN requirements.

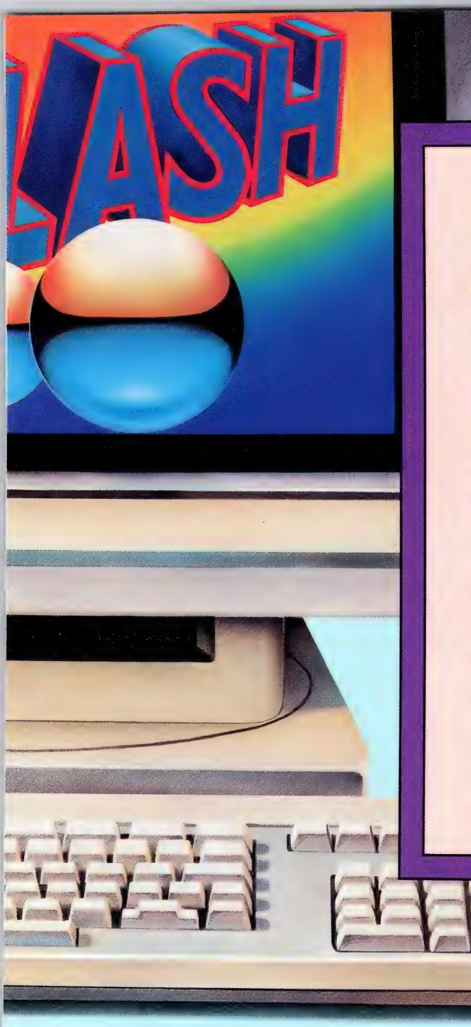
And our products are designed to pass the most stringent JAN performance demands, 100%.

Our wafer facility is a Class 10 manufacturing environment, and even our assembly areas are clean rooms.

Our flexible packaging automation systems let you take advantage of the LCCs and flatpacks you want, easily. And our 1.2 and 0.8 micron processes deliver record performance.

## A few military programs benefiting from Cypress Semiconductor CMOS technology:

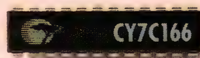
| | | | | |
|---|---|---|---|---|
| AHEP | AL-131 | ALQ-141 | ALR-56C | AMRAAM |
| ANDVT | AP-102 | ASR-9 | AWACS | B-52 |
| C-17 | E2-C | EA6B | EMSP | F-111 |
| F-14 | F-15 | F-15E | F-16 | F-18 |
| HAWK | ICNIA | JTIDS | LANTIRN | MAVERICK |
| MILSTAR | MILVAX | Patriot | Space Shuttle | |
| Sparrow | V22 | | | |



# 64K SRAM: 25ns!


65,536x1 Static RAM 25ns


16,384x4 Static RAM 25ns




16,384x4 Static RAM w/Output Enable 25ns


16,384x4 Static RAM Separate I/O 25ns


16,384x4 Static RAM Separate I/O 25ns


8192x8 Static RAM 35ns


8192x8 Static RAM 35ns

If you're looking to crank up the clock in your system, here is the SRAM speed and capacity you need.

We offer a variety of configurations—nibble-wide, bit-wide, byte-wide, and separate I/O—to give you *choice.*

Seven different 64K parts, all TTL-compatible, all with the lowest active power requirements available at this level of performance, and all with automatic power down.

And, our 0.8 micron process means very small die, so you can take advantage of board-saving skinny DIP packaging on *any* configuration. In fact, only Cypress offers high performance 8Kx8 SRAMs in 300 mil DIPs.

The net result: High performance, higher density, lowest power, and a cooler system, for greater reliability.

*Who uses Cypress Semiconductor circuits? Anyone who needs performance.*

*One example: Workstations with high computational demands and high throughput graphics.*

*Virtually every high performance engineering workstation company uses our high speed, low power CMOS circuits.*

A program that extends 38510 conformance to every part at Cypress, commercial or military.

And that program goes on to include:

Comprehensive Reliability Monitoring programs. . . .

Extensive Commercial Assurance screening. . . .

Military Product Assurance Programs, including Standard Military Drawings, JAN facility certification, and JAN parts. . . .

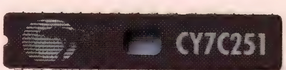
Total Individual Control, giving any individual the *obligation* to halt a design or process if quality is threatened. . . .

And Top-Down Quality Training, an ongoing series of management sessions ensuring that quality—conformance to specifications—always has top share of mind.

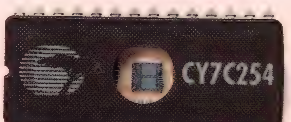
As a result, the Assembly Traceability Code marks the commitment of top management at Cypress Semiconductor to provide the highest quality in the semiconductor business. To have the programs in place to constantly drive toward Zero Defects.

# 128K PROM: Reprogrammable!

Yes, the photograph you see is actual size. Our CMOS processing means we can pack a full 128K into board-saving 300 mil-wide packaging.




16,384x8 Reprogrammable Power Switched PROM 45ns




16,384x8 Reprogrammable PROM 45ns

The benefits continue: 45ns gives you the speed you need for highest performance firmware. And, of course, CMOS means very low power. Combined with our power-down standby mode, you enjoy a significant power savings for each and every part you install, compared to any other non-volatile, high speed memory.

Now, let's talk *reprogrammability*. A windowed part can save you time and trouble in the development lab.

And windowed parts can save you considerable time and trouble in production, protecting you from expensive inventory obsolescence when firmware changes.

And even if you don't pick a windowed package, you still benefit from the technology. The floating gate process lets us test each and every memory cell on each and every part we ship, so you get the convenience of the highest incoming quality available.

### Do your other IC suppliers offer you the same assurance?

Look for an Assembly Traceability Code on all the circuits you see in your own product, and see just how fully committed your IC suppliers are to quality, and to accountability.

Quality is not an abstract or merely esthetic issue. Quality is a *measurable* conformity to standards that translates into measurable benefits for our customers.

So as long as you see that Assembly Traceability Code, you see the most visible evidence of our aggressive quality program. And our commitment to *your* product's quality.

# *64x8, 64x9 FIFOs: 35MHz!*

Our dual-port SRAM technology sets these FIFOs apart from all others.

By combining this SRAM technology with control logic and a read and write pointer, we've virtually eliminated the bubble-through delays associated with traditional FIFO parts.

*Cascadeable 64x8 FIFO 35MHz*

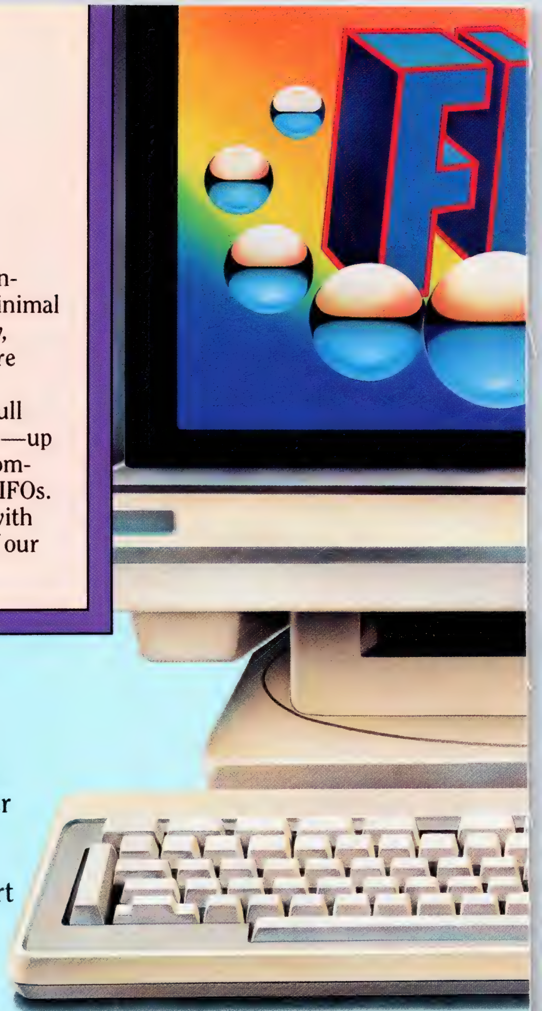
*Cascadeable 64x9 FIFO 35MHz*

The delay for input data to appear at the output is simply the time required to move a pointer and propagate an Output-Ready (OR) signal.

You can tie multiple FIFOs together on a common bus to increase word width. And you can increase depth with minimal performance penalty, because our FIFOs are cascadeable.

The parts deliver full 35MHz performance—up to 40% faster than competing cascadeable FIFOs.

And you get it all with the low, low power of our CMOS technology.




### *The Cypress Semiconductor quality advantage: The Assembly Traceability Code.™ **

Unique to Cypress, the Assembly Traceability Code is written proof of our unmatched quality and measurability commitment.

You'll find the ATC on every Cypress Semiconductor part.

Find that code on any other IC. If you can.

### *Here's why that Assembly Traceability Code is of measurable benefit to you:*

Quality, according to Philip B. Crosby, is tangible.

Quality is *conformance to requirements*.

In the semiconductor business, absolute conformance to requirements translates into the absolute minimum number of defects in parts shipped to customers, and into first-time-right customer service.

To achieve the *highest* quality, by this definition, a company requires complete commitment at all levels, including a commitment to *measuring* conformance.

100% traceability of every part through the Assembly Traceability Code is an extensive quality *discipline* that provides the necessary measurability.

It means every part shipped to every customer or distributor can be traced back to the original wafer lot, and thus to every operator, every supervisor, every machine, and every process that played a part in that lot.

That control contributes to better quality.

And the only way a semiconductor manufacturer can get that control is to control wafers *and* assembly, in house.

We do.

### *That code is a personal quality signature from every individual at Cypress Semiconductor.*

Not just because any defect can be traced back to the individual operator or supervisor on a given process or assembly step, important as that is.

But because personal accountability for corporate quality is the only way to set the highest corporate standards.

So that laser mark isn't just the signature of the process operators.

It is the signature of the designers who create parts that exceed conformance specifications instead of merely meeting them. Designers who help ensure at the outset that there is a *guard band*—sufficient to allow our parts to exceed data sheet specifications even given correlation variances between our test equipment and yours.

That same *guard band* mentality pervades our testing department, where a part we measure at exactly 25 nanoseconds would *never* qualify as meeting a 25ns spec.

No guard band, no qualification. To pass for 25ns here, a part has to run fast enough that acceptable correlation variations between different test equipment won't fail the part.

### *A meaningful mark. Read on.*

That Assembly Traceability Code is also the signature of the manufacturing engineers who designed quality procedures *into* the Cypress Semiconductor facilities from the ground up. So quality is designed into the production flow, not something to be added later.

One example—the Assembly Traceability Code is automatically marked on the package *immediately* after molding or sealing. No alternatives. Quality assurance designed in.

Those quality engineers were able to achieve JAN certification of the Cypress Semiconductor fab facilities for JAN level B on the first try!

How? Because these engineers, supported by management, use MIL-M-38510 and MIL-STD-883 as baselines, on which to build a true quality program.

# Good news: The new Cypress Semiconductor Data Book is available now.

## SRAM Whoosh List

**CY7C189** 16x4 Static RAM Inverting 15 ns
**CY7C190** 16x4 Static RAM Non-Inverting 15 ns
**CY74S189** 16x4 Static RAM Inverting 35 ns
**CY27S03A** 16x4 Static RAM Inverting 25 ns
**CY27S07A** 16x4 Static RAM Non-Inverting 25 ns

**CY7C122** 256x4 Static RAM Separate I/O 15 ns
**CY7C123** 256x4 Static RAM Separate I/O 7 ns
**CY93422A** 256x4 Static RAM Separate I/O 35 ns
**CY7C148** 1024x4 Static RAM $\overline{CS}$ Power Down 25 ns
**CY7C149** 1024x4 Static RAM 25 ns

**CY7C150** 1024x4 Static RAM Separate I/O 15 ns
**CY2148** 1024x4 Static RAM $\overline{CS}$ Power Down 35 ns
**CY21L48** 1024x4 Static RAM $\overline{CS}$ Power Down 35 ns
**CY2149** 1024x4 Static RAM 35 ns
**CY21L49** 1024x4 Static RAM 35 ns
**CY7C147** 4096x1 Static RAM $\overline{CE}$ Power Down 25 ns

**CY7C130** 1024x8 Dual Port Static RAM 35 ns
**CY7C132** 2048x8 Dual Port Static RAM 35 ns
**CY7C140** 1024x8 Dual Port Slave Static RAM 35 ns
**CY7C142** 2048x8 Dual Port Slave Static RAM 35 ns
**CY6116** 2048x8 Static RAM (600 mil) 35 ns

**CY7C128** 2048x8 Static RAM (300 mil) 25 ns
**CY7C168** 4096x4 Static RAM $\overline{CE}$ Power Down 25 ns
**CY7C169** 4096x4 Static RAM 25 ns
**CY7C170** 4096x4 Static RAM w/Output Enable 25 ns
**CY7C171** 4096x4 Static RAM Separate I/O 25 ns

**CY7C172** 4096x4 Static RAM Separate I/O 25 ns
**CY7C167** 16,384x1 Static RAM Separate I/O 25 ns
**CY7C185** 8192x8 Static RAM $\overline{CE}$ Power Down 35 ns
**CY7C186** 8192x8 Static RAM $\overline{CE}$ Power Down 35 ns
**CY7C161** 16,384x4 Static RAM Separate I/O 25 ns

**CY7C162** 16,384x4 Static RAM Separate I/O 25 ns
**CY7C164** 16,384x4 Static RAM $\overline{CE}$ Power Down 25 ns
**CY7C166** 16,384x4 Static RAM w/Output Enable 25 ns
**CY7C187** 65,536x1 Static RAM $\overline{CE}$ Power Down 25 ns
**JM38510/28901** 4096x1 JAN Static RAM $\overline{CE}$ Power Down 35 ns

## LOGIC Whoosh List

**CY2901C** CMOS 4-Bit Slice 31 ns
**CY2909A** CMOS Microprogram Sequencer 40 ns
**CY2911A** CMOS Microprogram Sequencer 40 ns

**CY2910A** CMOS Microprogram Controller 50 ns
**CY3341** 64x4 FIFO Serial Memory 2 MHz
**CY7C401** Cascadeable 64x4 FIFO 15 MHz
**CY7C402** Cascadeable 64x5 FIFO 15 MHz

**CY7C403** Cascadeable 64x4 FIFO w/Output Enable 25 MHz
**CY7C404** Cascadeable 64x5 FIFO w/Output Enable 25 MHz
**CY7C408** Cascadeable 64x8 FIFO w/Output Enable 35 MHz

**CY7C409** Cascadeable 64x9 FIFO 35 MHz
**CY7C510** 16x16 Multiplier Accumulator 45 ns
**CY7C516** 16x16 Multiplier 38 ns

**CY7C517** 16x16 Multiplier 38 ns
**CY7C901** CMOS 4-Bit Slice 23 ns
**CY7C909** CMOS Microprogram Sequencer 30 ns

**CY7C911** CMOS Microprogram Sequencer 30 ns
**CY7C910** CMOS Microprogram Controller 40 ns
**CY7C9101** CMOS 16-Bit Slice 30 ns

## PROM Whoosh List

**CY7C225** 512x8 Registered PROM 25 ns
**CY7C235** 1024x8 Registered PROM 30 ns
**CY7C281** 1024x8 PROM (300 mil) 30 ns

**CY7C282** 1024x8 PROM (600 mil) 30 ns
**CY7C245** 2048x8 Reprogrammable Registered PROM 25 ns
**CY7C291** 2048x8 Reprogrammable PROM (300 mil) 35 ns

**CY7C292** 2048x8 PROM (600 mil) 35 ns
**CY7C261** 8192x8 Reprogrammable Power Switched PROM (300 mil) 40 ns
**CY7C263** 8192x8 Reprogrammable PROM (300 mil) 40 ns

**CY7C264** 8192x8 Reprogrammable PROM (600 mil) 40 ns
**CY7C268** 8192x8 Diagnostic Registered PROM 40 ns
**CY7C269** 8192x8 Diagnostic Registered PROM 40 ns

**CY7C251** 16,384x8 Reprogrammable Power Switched PROM (300 mil) 45 ns
**CY7C254** 16,384x8 Reprogrammable PROM (600 mil) 45ns

## PLD Whoosh List

**PALC16L8L** Quarter-Power PAL20 Reprogrammable PAL™ 25 ns
**PALC16R8L** Quarter-Power PAL20 Reprogrammable PAL 20 ns

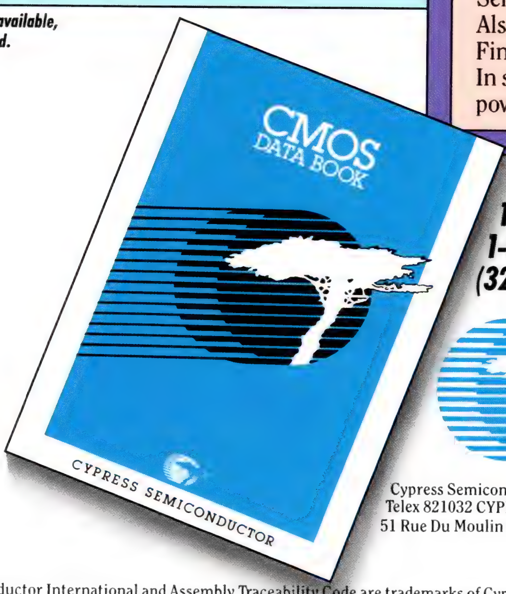
**PALC16R6L** Quarter-Power PAL20 Reprogrammable PAL 25 ns
**PALC16R4L** Quarter-Power PAL20 Reprogrammable PAL 25 ns

**PLDC20G10** Quarter-Power Generic 24-Pin Reprogrammable PLD 25 ns
**PALC22V10L** Quarter-Power Macro-Cell Configured 24-Pin PAL Device 25 ns

*Variety of speeds available, best speed is listed.*

## Yours for a fast, toll-free call:

You get full specifications on all these parts.
Plus, preliminary specs on our newest parts.
And, the Data Book includes full details on the Cypress Semiconductor Military program.
Also included are full descriptions of our packaging options.
Finally, the Data Book includes all our current Application Briefs.
In short, everything you need to take advantage of high speed, low power, ultra reliable CMOS.



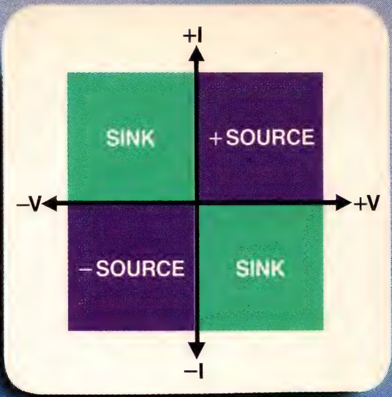

**Data Book Hotline:**
**1-800-952-6300, ask for Dept. C20**
**1-800-423-4440 (In CA), ask for Dept. C20**
**(32) 2-672-2220 (In Europe). (416) 475-3922 (In Canada).**

CYPRESS SEMICONDUCTOR

Cypress Semiconductor, 3901 North First Street, San Jose, CA 95134. Phone (408) 943-2666, Telex 821032 CYPRESS SNJ UD, TWX 910-997-0753. Cypress Semiconductor International, 51 Rue Du Moulin A Papier, BTE 11, 1160 Brussels, Belgium. Phone (32) 2-672-2220.

KEITHLEY ON SOURCES:

# QUALIFIED SOURCE




If you think there isn't much difference between a source and a power supply, then it's time you tried a Keithley source. The advantages are many.

**SENSITIVITY & DYNAMIC RANGE**

One of the chief benefits is the ability to set the exact range of output values you need. The key word here is "exact."

Keithley current sources have outputs programmable from ±0.5pA to 10A with output impedances up to $10^{14}\Omega$. That's precision no power supply can touch. In fact, **only** precision sources like these meet test requirements in applications such as DC parametric testing on devices and materials for semiconductors, resistivity studies such as microcrack analysis on new materials, and calibration of low current sensing instrumentation.

As further evidence, consider the ±50μV resolution of Keithley's Model 230 voltage source, necessary to achieve fine levels of control when extracting families of curves on semiconductors. Higher voltages to 100V are available for biasing devices and supplying power to circuits.

For calibration applications that need accurate low current, the Model 263 sources as low as ±50aA. Lastly, for calibration of charge ranges on electrometers and nuclear instruments, the Model 263 will source to 20μC. Voltages to 20V are also available.

**THE RANGE OF KEITHLEY SOURCES**

| Source Type | Output Range | Model |
|---|---|---|
| Voltage | ±50μV to 100V | 230 |
| Current | ±0.5pA to 100mA | 220 |
| Current | ±0.5nA to 100mA | 224 |
| Voltage/ Current | ±1mV to 100V<br>±100μA to 10A | 228 |
| Calibrator | ±50aA to 20mA<br>±0.5fC to 20μC<br>±5μV to 20V<br>1kΩ to 100GΩ | 263 |

**FOUR-QUADRANT OPERATION**

Unlike most power supplies, Keithley sources can both source and sink when connected to the DUT. This four-quadrant operation can either supply power to the device or act as a programmable load up to the full rated power of the output. Sink capability can also help reduce transients and dissipate energy stored in circuit reactances.

**PROGRAMMABILITY**

Keithley sources are simple to integrate into your IEEE-488 system with convenient built-in features such as digital I/O, 100-point memory, dwell times, and in and out hardware triggers. Keithley sources are easy to learn and operate, since all Keithley models use similar device-dependent commands.

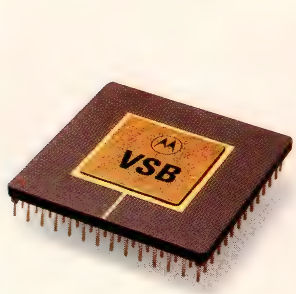
Call or write the Keithley Product Information Center for more on our complete line of programmable voltage and current sources, or to find out how we can help with any of your programmable Source, Measure, or Connect needs. Keithley Instruments, Inc., 28775 Aurora Road, Cleveland, Ohio 44139. (216) 248-0400.

SOURCE • MEASURE • CONNECT

KEITHLEY

CIRCLE NO 92

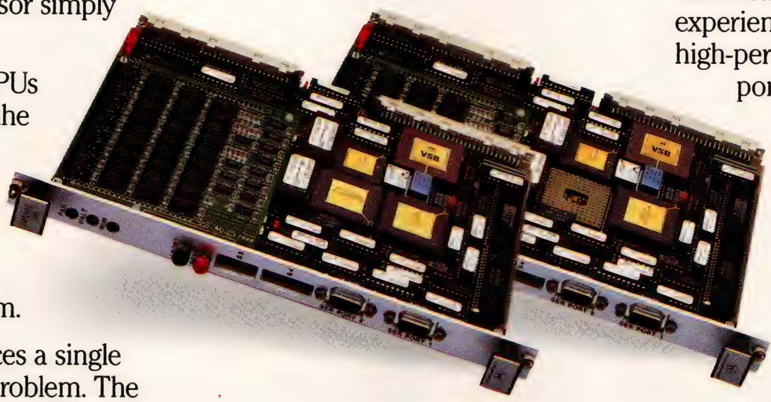
# Motorola announces one of the smallest advances in the history of VME.



**Motorola puts awesome multiprocessing performance on two new single-board computers.**

As computer applications get more complex, OEMs are turning more to multiprocessing designs. To handle things like CAD/CAM, robotics, signal processing, simulation and large-scale data acquisition, a single processor simply can't keep up.

Adding several CPUs to a system off-loads the main processor, but what happens to the system bus? It frequently reaches saturation, slowing down the entire system.




Motorola introduces a single chip solution to this problem. The **V**ME **S**ubsystem **B**us, a fast, 32-bit secondary bus, has been implemented on a gate array at Motorola.

**The end of the multiprocessor traffic jams.**

The VSB sub-bus removes traffic from the VMEbus, increasing total system throughput. And by saving space on the VSB—and other components—Motorola has been able to pack an impressive array of multiprocessor functions onto two standard VME boards: the MVME135 and MVME136. These highly integrated microcomputers include *all* the functions usually required for high-performance multiprocessing. In addition to the VSB, they feature the MC68020 with floating-point coprocessor, both running at either 16.67 or 20.0MHz.

For virtual memory environments, a demand-paged memory management unit can also be added. Plus 1 Megabyte of shared local dynamic RAM is included—with optional parity—designed to operate with zero wait states.

Included in the 135/136 modules are many special hardware features that facilitate multiprocessing. Things like MP control and status registers. An expanded interrupt-handling mechanism. And master/slave control bit settings.

**Hardware alone is hardly enough.**

Complete multiprocessing hardware on a single board saves you design time and system space. But to get your application up and running on a tight schedule, it takes software and support tools too. Like those available from Motorola.

If you're building a multi-user/multi-tasking system, you can use our version of AT&T's UNIX® System V Release 3, with Remote File Sharing. For real-time tasks, there's our full-featured VERSAdos™ operating system, as well as debugging firmware with on-board diagnostics. Then too, you have access to third-party software such as OS-9,™ MTOS,™ PDOS,™ pSOS,™ RTUX,™ and VRTX.®

Add to that Motorola's in-depth technical support. We have more experience in building reliable, high-performance VME system components than any other vendor. Plus a specialized systems and support staff available at over 100 field offices worldwide.

To see how good multiprocessors can come in small packages, call us toll-free today: **1-800-556-1234 Ext. 230** (in California, 1-800-441-2345 Ext. 230). Or write; Motorola Microcomputer Division, 2900 South Diablo Way, Tempe, AZ 85282.

**MVME135/136 Highlights**

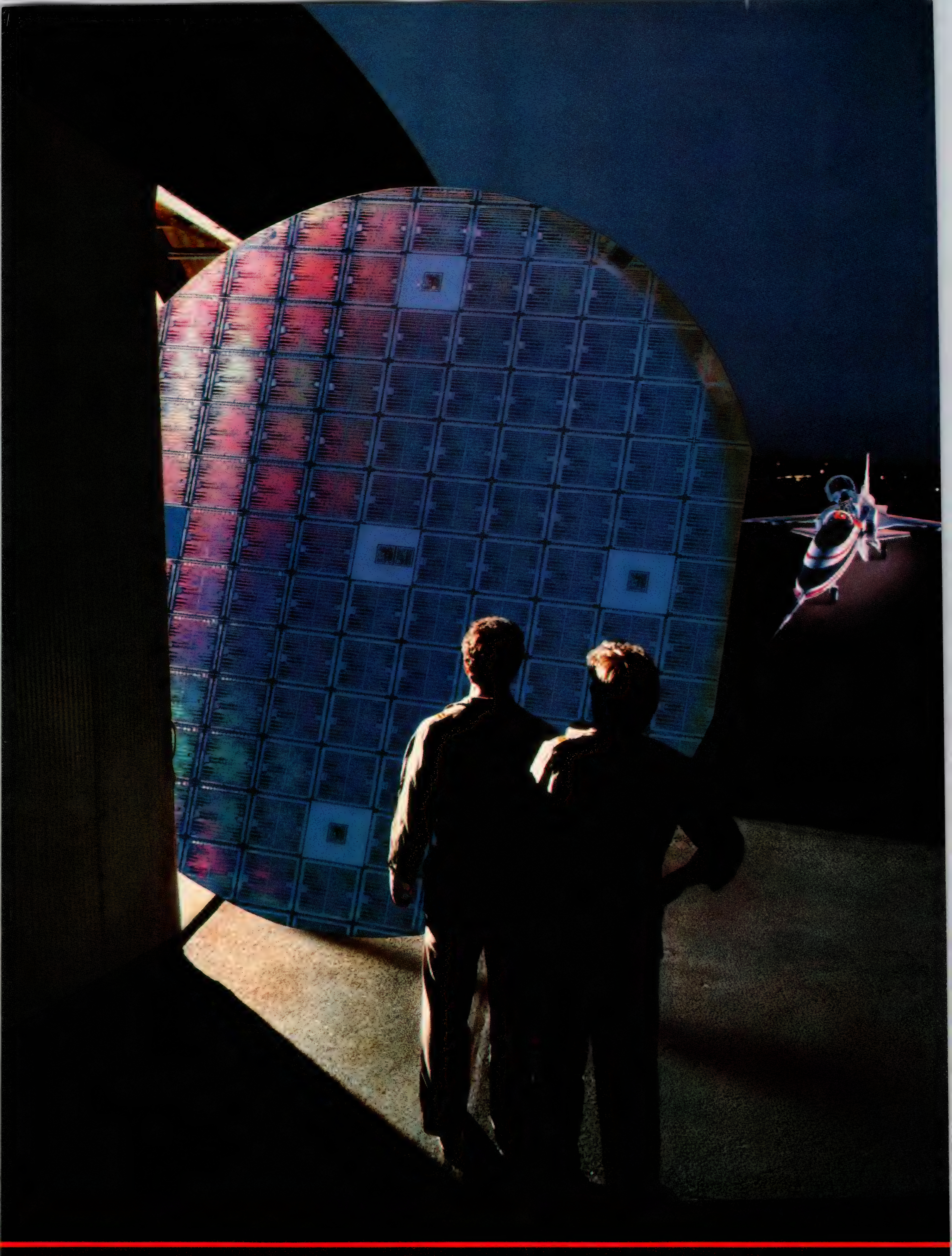
| Model | Description |
|---|---|
| MVME135 | VMEbus 32-bit SBC; 16.67-MHz MC68020 CPU; MC68881 FPU; 1Mb on-board DRAM; up to 512 Kb EPROM; two RS-232-C serial ports; two 16-bit timers; master/slave interface; MP control and status registers; system controller |
| MVME135-1 | Same as MVME135, but with 20-MHz MC68020 CPU |
| MVME136 | Same as MVME135, but with MC68851 PMMU |

OS-9 is a trademark of Microware Systems Corporation. MTOS is a trademark of Industrial Programming Inc. PDOS is a trademark of Eyring Research Institute, Inc. pSOS is a trademark of Software Components Group. RTUX is a trademark of Emerge Systems. VRTX is a registered trademark of READY SYSTEMS. VERSAdos is a registered trademark of Motorola, Inc. UNIX is a registered trademark of AT&T.

**MOTOROLA** *Microcomputer Division*

*Approaching our technology from your point of view.*

CIRCLE NO 91



CIRCLE NO 90

# CALENDAR

**Designing Signal Processors with DSP and Bit-Slice Chips** (short course), San Diego, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 1 to 4.

**Effective Skills for Technical Managers** (short course), Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 1 to 4.

**Modern Electronic Packaging,** Seattle, WA. Technology Seminars, Box 487, Lutherville, MD 21093. (301) 269-4102. September 9 to 11.

**Invitational Computer Conference Computer Graphics Series,** Fort Lauderdale, FL. BJ Johnson & Associates, 3151 Airway Ave, #C-2, Costa Mesa, CA 92626. (714) 957-0171. September 10.

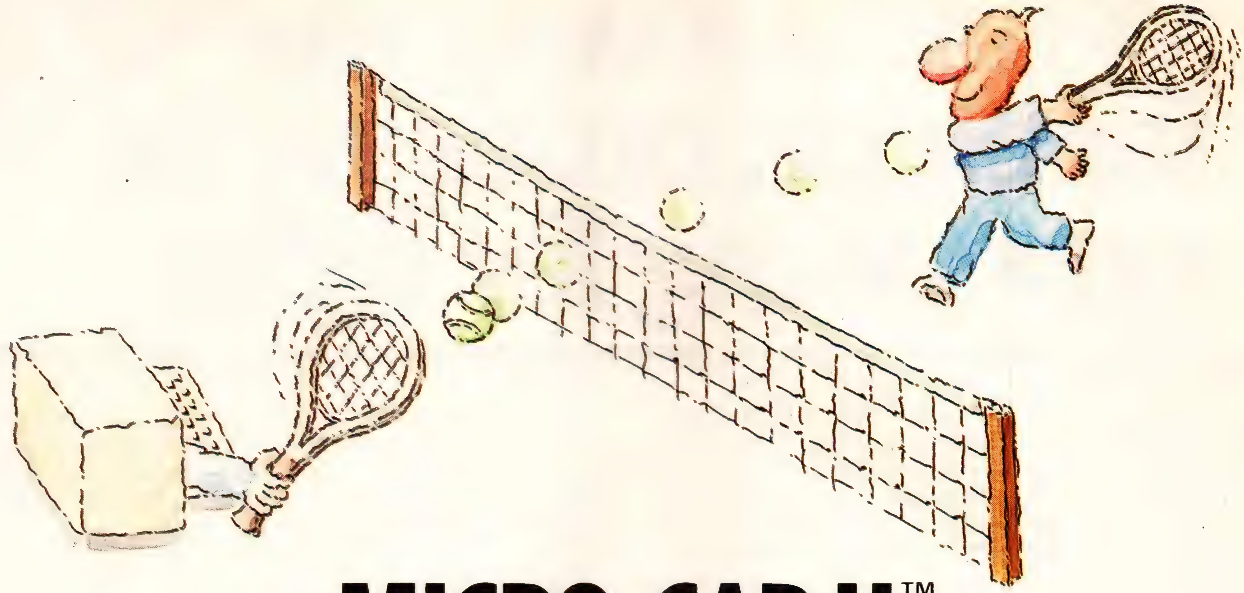
**Integrated Manufacturing Solutions** (IMS '87), Long Beach, CA. Intertec Communications, 2472 Eastman Ave, Bldg 33-34, Ventura, CA 93003. (805) 658-0933. September 14 to 18.

**Hands-On Microprocessor Software, Hardware, and Interfacing** (short course), Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 15 to 17.

**PCB Expo,** Minneapolis, MN. PMS Industries, 1790 Hembree Rd, Alpharetta, GA 30201. (404) 475-1818. September 15 to 17.

**Effective Skills for Technical Managers** (short course), Los Angeles, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 15 to 18.

**IEEE Bipolar Circuits and Technology Meeting,** Minneapolis, MN.

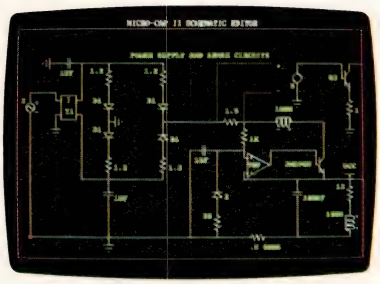


# MICRO-CAP II.™

# The CAE tool with fully interactive analog simulation for your PC.

Spectrum Software's MICRO-CAP II® is fast, powerful, and feature rich. This fully interactive, advanced electronic circuit analysis program helps engineers speed through analog problems right at their own PCs.

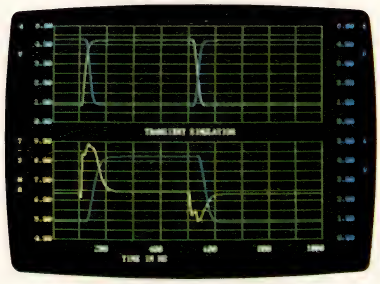
MICRO-CAP II, which is based on our original MICRO-CAP software, is a field-proven, second-generation program. But it's dramatically improved.



*Schematic Editor*

MICRO-CAP II has faster analysis routines. Better resolution and color. Larger libraries. All add up to a powerful, cost-effective CAE tool for your PC.

The program has a sophisticated integrated schematic editor with a pan capability. Just sketch and analyze. You can step



*Transient Analysis*

component values, and run worst-case scenarios—all interactively. And a 500-type* library of standard parts is at your fingertips for added flexiblity.

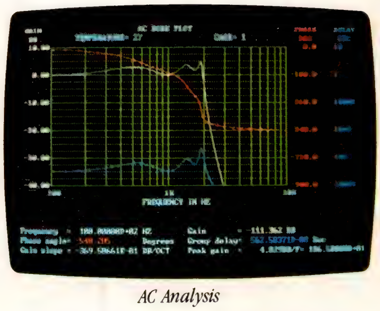
MICRO-CAP II is available for IBM® PCs and Macintosh.™ The IBM version is CGA, EGA, and Hercules® compatible and costs only $895 complete. An evaluation version is available for $100. Call or write today for our free brochure and demo disk. We'd like to tell you more about analog solutions in the fast lane.

- Integrated schematic editor
- Fast analysis routines
- High-resolution graphic output
- Standard parts library of 500* types

*IBM versions only.

**CIRCLE NO 89**

- Transient, AC, DC, and FFT routines
- Op-amp and switch models
- Spec-sheet-to model converter*
- Printer and plotter* hard copy



*AC Analysis*

spectrum

1021 S. Wolfe Road, Dept. E
Sunnyvale, CA 94087
**(408) 738-4387**

MICRO-CAP II is a registered trademark of Spectrum Software.

Macintosh is a trademark of McIntosh Laboratory, Inc. and is being used with express permission of its owner.

Hercules is a registered trademark of Hercules Computer Technology

IBM is a registered trademark of International Business Machines, Inc.

NEW
850 & 1550 nm

# What we've done for electronics we're now doing for light.

You've known HP for innovation in electronic test and measurement equipment. And now we've moved into light. With a new family of fiber optic test instruments that brings accuracy and speed to your measurements. And offers a price/performance ratio that gives you excellent value, too.

The HP 8152A Optical Average Power Meter with its optical heads features better than 5% absolute accuracy (NBS traceable) and 1% linearity between 450nm and 1700nm. You can even connect two optical heads for direct insertion loss measurements.

The HP 8158B Optical Attenuator is the first of its kind: *one* instrument that covers both single- and multimode fiber applications for either the 600nm to 1200nm or 1200nm to 1650nm wavelength range.

The HP 8154B LED Sources (850nm, 1300nm, 1550nm) have better than 0.001dB stability, and the HP 8159A Optical Switch offers outstanding repeatability.

Our family is ideal for short- and long-wavelength applications, fully HP-IB programmable for automated control, and compact and lightweight in design.

## Call HP today!

See the difference that HP fiber optic test instruments can make for you. Call your local HP sales office listed in the telephone directory white pages. Ask for the electronic instruments department.

CIRCLE NO 88

HEWLETT PACKARD

DESIGNED FOR HP-IB SYSTEMS

HP-IB: Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path to a measurement system.

EI15602B

# CALENDAR

Janice Jopke, BCTM, 5016 W 99th St, Bloomington, MN 55437. (612) 835-6742. September 21 to 22.

**Designing Signal Processors with DSP and Bit-Slice Chips** (short course), Boston, MA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 22 to 25.

**Hands-On Microprocessor Software, Hardware, and Interfacing** (short course), San Diego, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 22 to 25.

**Optical Filing System Conference,** New York, NY. Skan Teknologies, Box 149, Cedarhurst, NY 11516. (212) 809-5570. September 28.

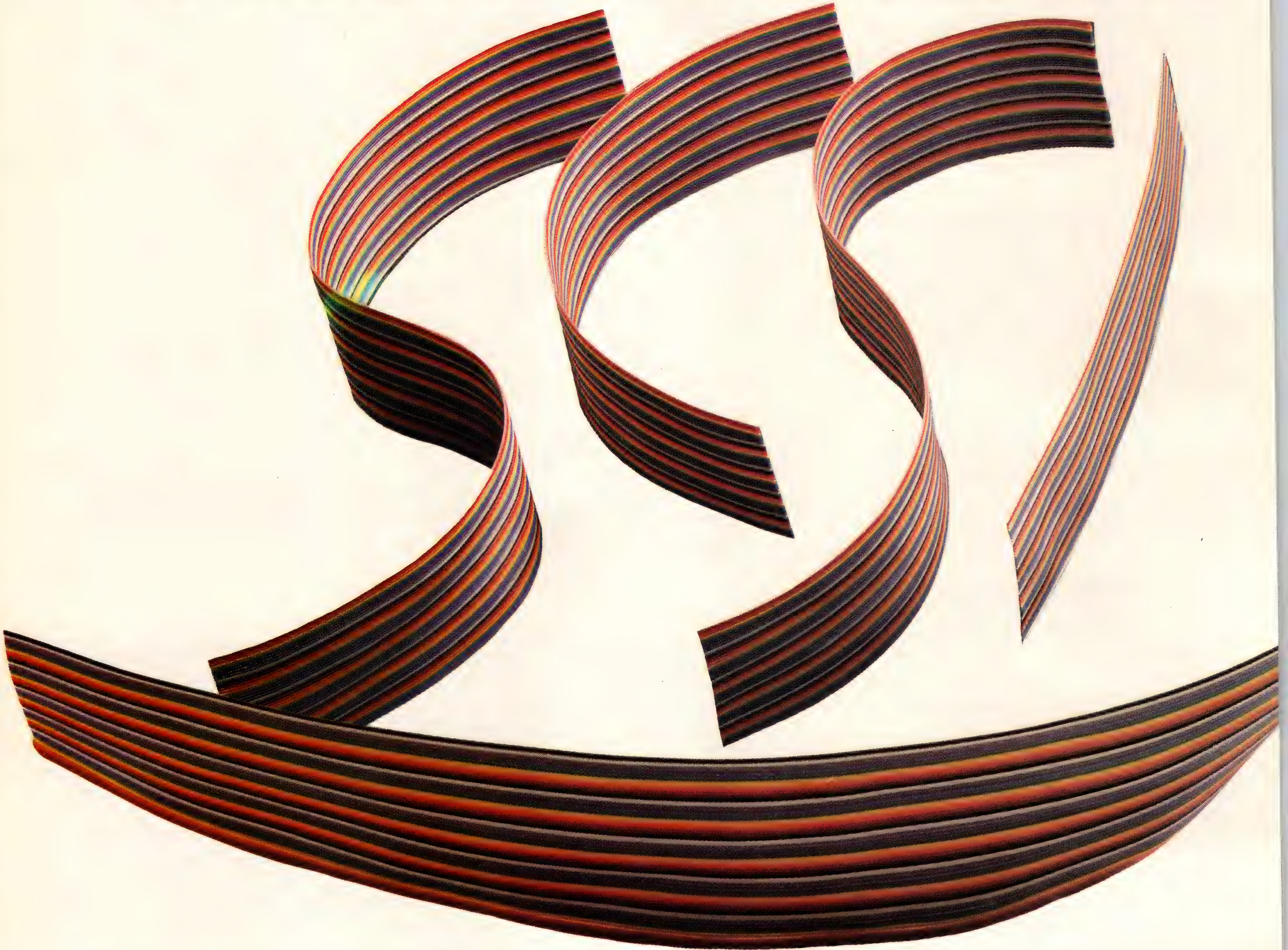
**Canadian High Technology Show,** Toronto, Canada. Canadian High Technology Week, 214-2487 Kaladar Ave, Ottawa, Ontario, Canada, K1V 8B9. (613) 731-9850. September 28 to 30.

**Designing Signal Processors with DSP and Bit-Slice Chips** (short course), Palo Alto, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 29 to October 2.

**Hands-On Expert Systems Design and Development** (short course), Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 29 to October 2.

**Invitational Computer Conference Computer Graphics Series,** Newton, MA. BJ Johnson & Associates, 3151 Airway Ave, #C-2, Costa Mesa, CA 92626. (714) 957-0171. October 1.

# WE PUT A GREAT INTERFACE



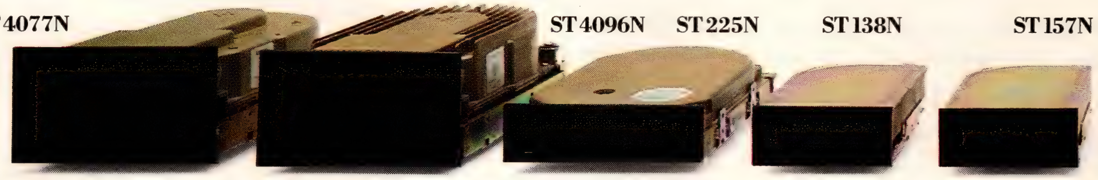
As an intelligent interface for small computers, SCSI has become a great standard, supporting multiple peripherals on a single cable.

Seagate supports that standard with the widest variety of SCSI hard disc drives available: 3½″ and 5¼″. Half-heights and full-heights. With capacities from 20 to 160 MB.

Seagate's SCSI drives have built-in features that give your products these advantages:

- Superior performance through higher transfer rates.
- Greater system throughput with overlapped operations, low command overhead and defect management that is automatic and transparent.
- Improved data integrity with enhanced recovery techniques.

ST 4077N ST 4096N ST 225N ST 138N ST 157N

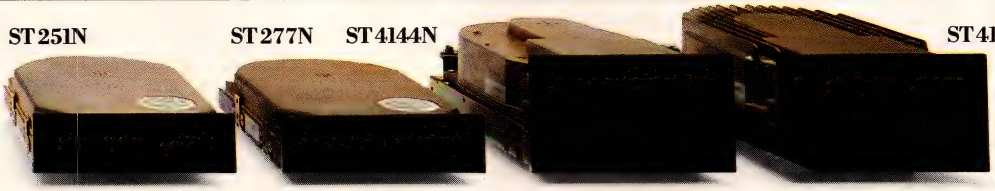


# WHERE IT DOES THE MOST GOOD.


- Superior reliability due to fewer cables, connectors and components.
- Increased flexibility with a choice of command sets: common (CCS) or customer-defined.
- Direct hardware connections to computers with built-in SCSI ports.
- Simple PC installation with our ST01 host adaptor.

Customers have come to expect this attention to performance, quality and reliability from Seagate. That's why they've bought more than 6 million of our hard disc drives.

If you want to put great drives with a great interface in your system, call us. 800-468-DISC.
Or write: Seagate Technology, 920 Disc Drive, Scotts Valley, CA 95066.



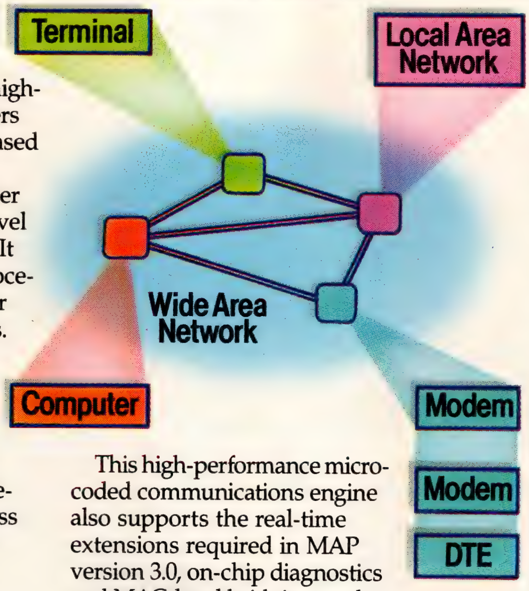

Seagate
The first name in disc drives.

CIRCLE NO 87

# Motorola M68000

Your high-performance systems require a wide range of microprocessor and peripheral support. The versatile M68000 Family serves those needs with product that's well documented, easy to use, cost effective, easy to get and as varied as your applications.

## Versatile solutions for the need to communicate data.




Motorola has developed a family of high-performance communications controllers called Serial Processing Units (SPUs) based on a modular design concept.

The MC68605 X.25 Protocol Controller (XPC) independently generates link-level commands for X.25 and X.75 networks. It expertly terminates the Link Access Procedure Balanced (LAPB) at the full 1.544 or 2.048 data rates provided by T1 facilities. It has passed rigorous Defense Data Network certification tests, and its global acceptance is suggested by use on packet networks all over Europe.

The MC68824 Token Bus Controller (TBC) is the only single-chip VLSI implementation of the IEEE 802.4 Media Access Control (MAC) sublayer defined in the Manufacturing Automation Protocol (MAP) specification.

This high-performance microcoded communications engine also supports the real-time extensions required in MAP version 3.0, on-chip diagnostics and MAC-level bridging, and implements the recommended standard MAC-to-physical serial interface.

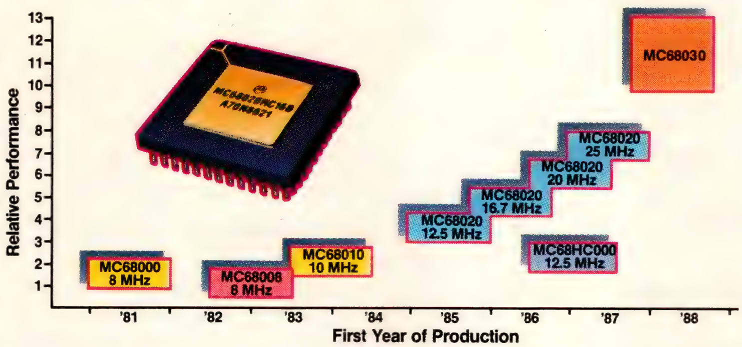
The MC68184 Broadband Interface Controller is, with RF circuitry, the broadband modem required for each node of a broadband MAP network.

In addition to the SPUs, M68000 communications peripherals include the MC68661 Universal Synchronous Communications Controller, the MC68652 Multi-Protocol Communications Controller, several DMA circuits and a variety of miscellaneous single- and multifunction devices. **A**

## The highest-performance 8/16/32-bit MPUs smooth the migration path for your products.

Common internal 32-bit architecture. Object-code software compatibility. Just two of the reasons M68000 Family microprocessors from the 8-bit MC68008 to the 32-bit industry standard MC68020 give your products both the highest performance and the smoothest migration path.

Operating speeds range from 8 MHz for low-cost applications to the industry's fastest general purpose MPUs at 25 MHz.




And, products based on M68000 Family MPUs are the standard for UNIX® operating systems, CAD/CAM workstations, next-generation office automation, multi-user/multi-tasking departmental computers, color graphics as well as for real-time factory automation.

M68000 MPUs are also preferred engines for high-performance artificial intelligence with large linear addressing requirements.

Large, flexible 32-bit register set, large linear address space, powerful yet simple instruction set and flexible addressing modes all add up to the competitive advantage for your M68000 MPU-based product. **B**

UNIX is a registered trademark of AT&T.
HDS-300 is a trademark of Motorola Inc.

## Emulate in real time, debug in record time, with the most powerful M68000 Family development system.

Motorola's HDS-300™ hardware/software development station can give you an important edge in slashing development time and moving your product to market when you design in one of the industry's leading M68000 family MPUs.

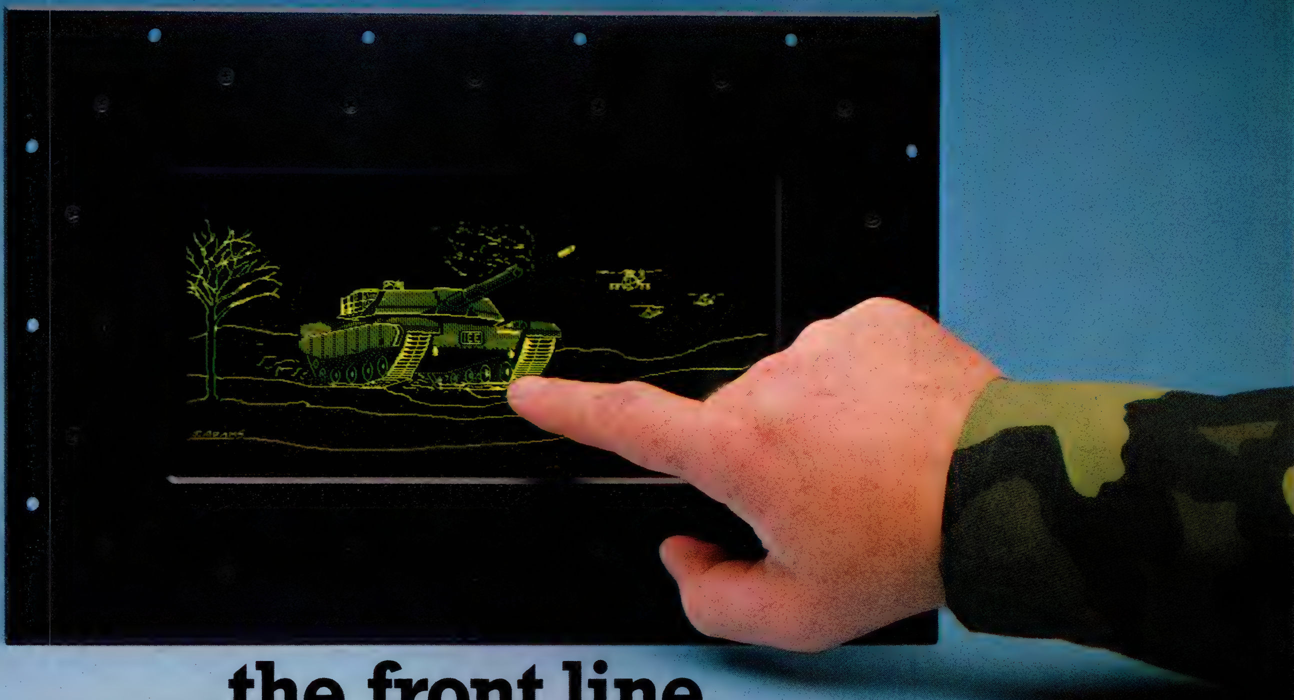
It simplifies and speeds up debugging and testing of your MPU hardware and software, and in the appropriate configuration can also provide source-level debug for even greater development-time reduction.

Labor-saving features include real-time no wait-state emulation to 25 MHz, system performance analysis and "C" language source-level debugging. Cost efficiency is achieved with a modular approach that permits operation with any of the available emulator modules, including MC68020, MC68010, MC68000 and MC68008.

There are so many more reasons why the HDS-300 development station is the ultimate emulation and analysis tool for systems based on MC68000 Family processors. Discover them. **C**

# INTRODUCING THE NEV
# RECHARGEABLE BATTER

# Our EL displays perform best where you need EL most:



# ...the front line.

If you need genuine, full-military electroluminescent (EL) displays, you are reading the right ad. Every display we offer is designed from the ground up to meet the toughest military specifications such as MIL STD 810C, etc.

Key features are shallow depth, complete on-board electronics and power converter, multiple interfaces and options such as touch entry, enclosures, etc. Custom sizes and interfaces can be supplied to meet your specific application.

If you don't need full military temperature ranges, we can reduce the cost of the display—yet retain a high level of ruggedness and performance—by substituting some components with selected commercial parts.

**Need "front line" keyboards too? We've got 'em. Custom military TEMPEST keyboards.**

- Full-travel
- Nuclear hardened
- Submersible
- Multiple interface options

For more information on these products, contact your local IEE representative now or call Stuart Siegel at (818) 787-0311, Ext. 237.

Our 40th year of supplying **tough** products for **tough** customers!

IEE® 40th Anniversary

*INDUSTRIAL ELECTRONIC ENGINEERS, INC.*
*Military Products Group*
*7740 Lemona Ave., Van Nuys, CA 91409-9234*
*Tel.: (818) 787-0311 • Telex: 4720120 IEE PPD*
*FAX: (818) 902-3723 (G2/G3)*

**Circle 78 for immediate application**

**Circle 117 for reference material**

# WHAT DRIVES

# A LEADER?

You do.

We do.

On one hand, there's your drive to find new applications and new markets. On the other, there's our drive to meet your needs.

And as partners, we both end up in the lead.

You give us the impetus to stay a generation or more ahead of the competition. And we give you the products to do the same.

Like our high-performance, high-capacity Winchester drive families, from 85MB to 760MB. And our first high-capacity optical product, a 5¼-inch, 800MB WORM drive.

So keep pushing us.

Because the further you drive Maxtor, the further we'll drive you.

Maxtor Corporation, 211 River Oaks Parkway, San Jose, CA 95134, (408) 432-1700, TELEX 171074.

Sales offices: Austin (512) 345-2742, Boston (617) 872-8556, Orange County (714) 472-2344, New Jersey (201) 747-7337, San Jose (408) 435-7884, Woking, England (44)/4862-29814.

Maxtor

Distributed by: Anthem Electronics, Inc., Lionex Corporation, Pioneer-Standard Electronics, Inc., Quality Components, Inc., Storex Corporation.



CIRCLE NO 85

# EDITORIAL

## Sell overseas

During the next three or four years, fewer and fewer companies with US-only market strategies will remain in business. Those that survive will be the ones that sell their services and products overseas. Unfortunately, many small- and medium-size companies think exporting is a formidable job. Such companies can take advantage of programs run by the US Department of Commerce's International Trade Administration (ITA).

Most of the ITA's export-development programs are inexpensive. For example, for a fee of $90 per country, the ITA analyzes your product information and prices, and then identifies business contacts in each country you specify. The ITA also furnishes business leads through its Trade Opportunities Program (TOP). The TOP lists firms that have an interest in specific types of US products or services, like computer hardware or software. Prices range from $62.50 for a list of 50 leads in your product category to $175 for a year's subscription to the weekly TOP Bulletin. Each bulletin contains between 300 and 400 contacts in all product categories.

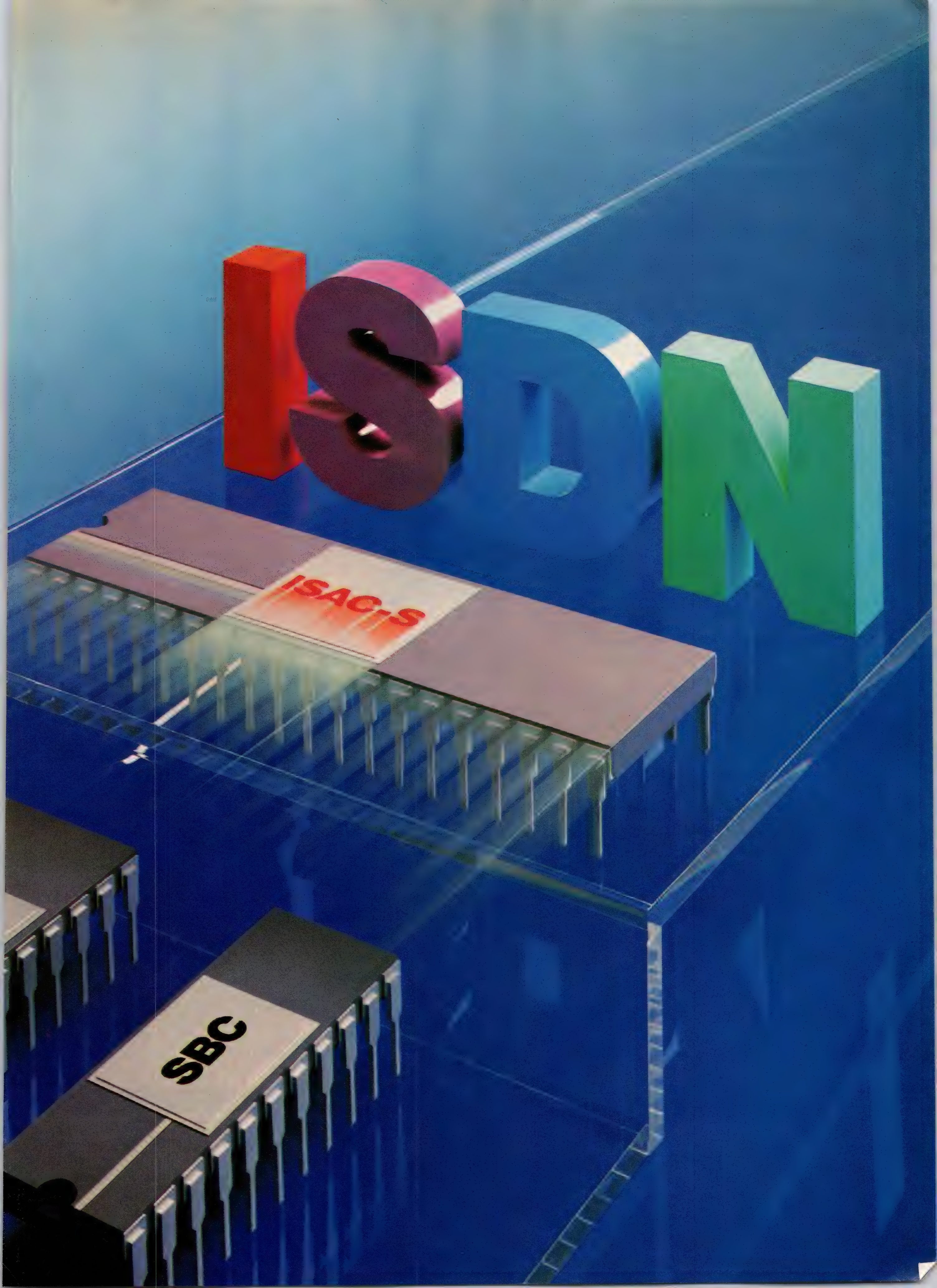
You might also consider the ITA's annual Matchmaker Program, which takes place this year on November 2 and 6. Participants spend 2½ days in Paris and 2½ days in London meeting with qualified, prescreened contacts who are actively seeking electronic products from the USA. The contacts can represent distributors and licensees as well as companies looking for joint ventures. Also, legal-affairs experts, customs officials, and bankers are available during the program to answer questions and to provide advice about the import/export business.

Last year, after three days in London, the 41 firms that participated in the Matchmaker Program reported new export sales of more than $7.5 million. That's an average of about $183,000 per company as the result of a 3-day visit. The fee for the 5-day 1987 Matchmakers Program is $1500, plus travel and living costs. For more information, send two sets of product literature to the US Department of Commerce, ITA, US and Foreign Commercial Service, HCHB 2116, Washington, DC 20230. Tell them who you are and what type of contacts you're looking for. You can also contact your local Department of Commerce office.

US companies now export $5.5 billion worth of electronic equipment to the United Kingdom, and the Department of Commerce expects the market to grow for three or four years at an annual rate of 8 to 10%. So, it's the right time to head your company toward the export market.

Jon Titus

**Jon Titus**
**Editor**


ISDN
ISAC-S
SBC

# NOW

## TO-220 look-alikes in a military package

# M-Pak™ HEXFET®

Designing our new hermetic M-Pak HEXFET power MOSFET like the TO-220 makes it one of the most efficient fully-isolated packaging alternatives for solving critical space and weight requirements.

For example, the M-Pak can be used to replace TO-3s, TO-61s, TO-66s, and power hybrids. There's no need for isolation mounting hardware. And installation time is drastically reduced.

Inside the M-Pak is a copper base brazed to a steel alloy with the chip mounted on a beryllium-oxide isolation pad for maximum power handling.

It's these and other features, like gold-plating, that also enhance the hi-rel performance of M-Pak HEXFETs and power hybrids for severe environments.

M-Pak HEXFETs range up to 500 volts, with Rds(on) values subject to die size. For complete data, call (213) 607-8887. Today.


**HEXFET Technology...**

M-Paks contain chips produced with o[ur] exclusive HEXFET process, resulting i[n] unsurpassed quality and reliability.


**Call now for your free copy of our new 1987 Mil-Qualified/Hi-Rel Products Catalog**

**Number 1 in power MOSFETs**

# International IOR Rectifier

**WORLD HEADQUARTERS:** 233 KANSAS ST., EL SEGUNDO, CA 90245. U.S.A. (213) 772-2000. TWX 910-348-6291, TELEX 472-0403
**EUROPEAN HEADQUARTERS:** HURST GREEN, OXTED, SURREY RH8 9BB. ENGLAND TELEPHONE (088 33) 3215/4231. TELEX 95219

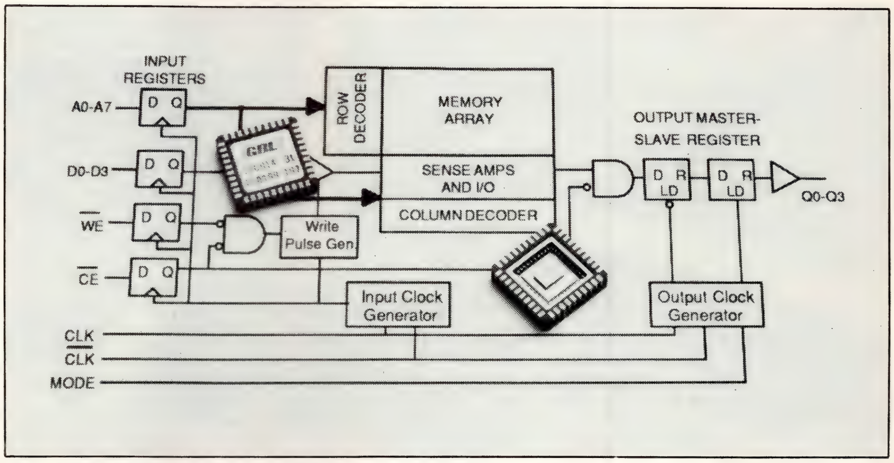
**Power MOSFETs • CMOS Power ICs • Commercial/Custom Power Packages • Schottkys Rectifiers • Thyristors (SCRs) • Diode Bridges • Molded Circuits • Assemblies**

**CIRCLE NO 83**

# Off-the-shelf GaAs ICs serve both military and commercial applications

Dave Pryce, *Associate Editor*

Although it isn't likely that gallium arsenide will replace silicon in large-volume, low-performance (by GaAs standards) applications, GaAs ICs have found a niche in high-performance environments. The military is presently the single largest user of GaAs ICs. It uses high-frequency broadband MMICs (monolithic microwave integrated circuits), both custom and standard, in a multitude of applications. Moreover, it is also driving the use of high-speed static RAMs in applications where ultrafast cycle times are important, thus providing an impetus for broader product acceptance in commercial applications.




***The 12G014 256×4-bit static RAM** from GigaBit Logic has a pipelined architecture and a cycle time of 3 nsec.*

**Gallium arsenide has advantages**

The inherent performance advantages of gallium arsenide—high-frequency capability, fast switching, good radiation tolerance, and the potential for high-temperature operation and low power dissipation—attracted the military to GaAs devices for use in satellites and radar, ECM, and $C^3I$ systems.

Unfortunately, for commercial applications, gallium arsenide has suffered from pricing problems. As circuits using the material become increasingly popular in fiber-optic communication links, test instrumentation, and ultrahigh-speed computers, this situation may well change. These applications are of interest to designers of both military and commercial equipment and have been instrumental in motivating suppliers of GaAs ICs to develop and produce off-the-shelf parts such as broadband amplifiers, fiber-optic circuits, logic and memory circuits, and op amps—all capable of operating at UHF or microwave frequencies.

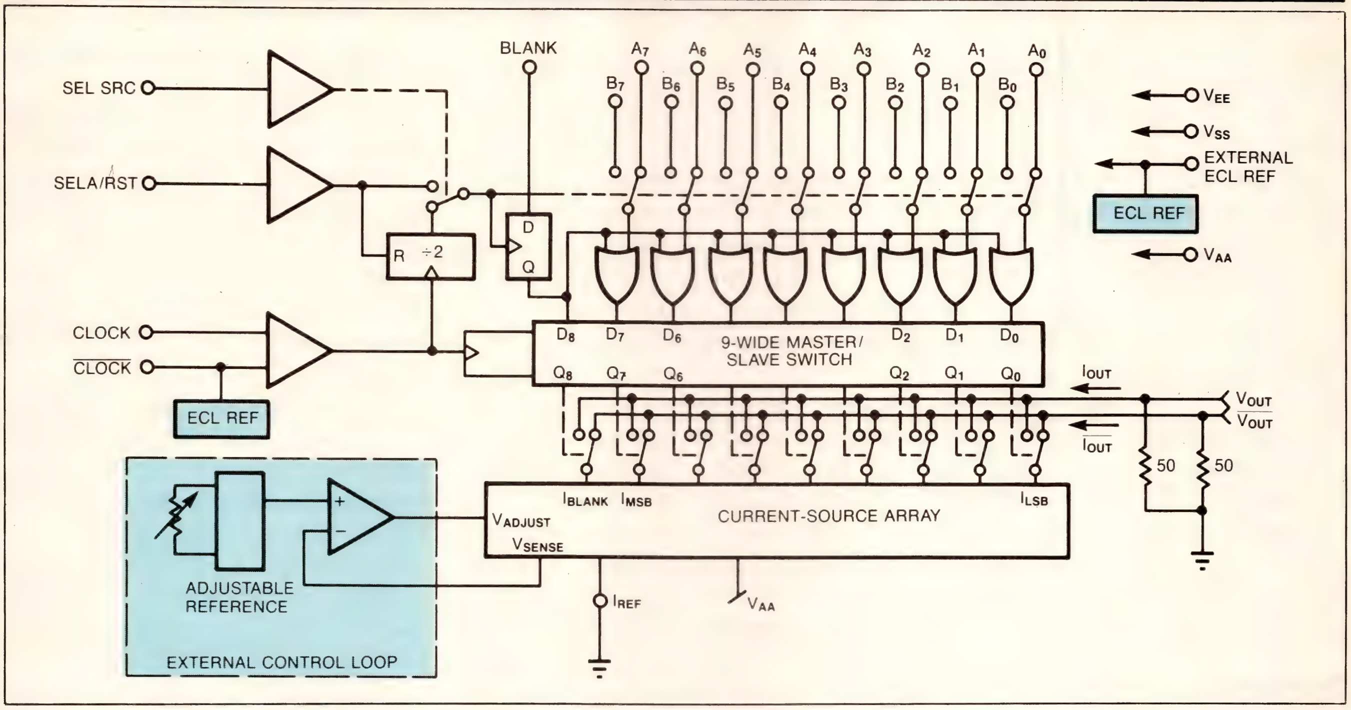
Some chip makers are designing commercial parts that meet not only the lower commercial and industrial temperature ranges but also the military temperature range of −55 to +125°C. The ability of selected commercial parts to meet the military temperature range could have a synergistic effect on both the military and commercial markets. If the military has sources for immediately available qualified parts, then military purchases will help alleviate the over-capacity problem now existing with some vendors. In turn, the elimination of excess capacity can help reduce costs.

Indeed, the pricing problem typically has been a Catch-22 situation. GaAs products haven't been used in high-volume applications because of high cost, and volume production (at low cost) hasn't been possible because of relatively low sales.

The other aspect of the pricing problem is one of perception. Many potential industrial and commercial users view GaAs ICs as 10 to 20 times more expensive than silicon, but this isn't really true. For any reasonable production run (which can be relatively small compared to silicon), the extra cost of GaAs reflects its performance advantages—the price difference is closer to 5:1.

GigaBit Logic's 12G014, a 256×4-bit static RAM with a cycle time of 3 nsec, exemplifies this price/performance tradeoff. Note that the 12G014 costs $117 (1000) and $99.50 (5000); 1k-bit static RAMs in silicon are available for $15 to $20 in quantities of 1000 and about $12 in quantities of 5000. However, the two types don't provide the same performance.

The 12G014 is not only much faster, but is more architecturally advanced than a simple static RAM because it provides pipelined and self-timed operation. Pipelining refers to the on-chip input and output registers, which allow the all-important cycle time of the system to be the same as the cycle time of the 12G014 itself—3 nsec. Silicon ECL RAMs are available with 5- to 7-nsec access times (not cycle times), but the delays associated




***This super-fast TQ612 8-bit DAC*** *from TriQuint Semiconductor finds application in high-resolution video displays and in fast-frequency-hop communications. On-chip references interface with ECL circuits.*

with the required I/O registers result in cycle times in the 8- to 12-nsec range.

In addition to its on-chip registers, the 12G014 contains an on-chip clock generator and a write pulse-generator that are critical to achieving the 333-MHz cycle rate. The access time of the 12G014's memory array itself is 1.5 nsec, which is the figure you should use when making comparisons to fast silicon static RAMs with their nonpipelined architectures. The 12G014's write cycle time is as fast as its read cycle time, a characteristic not generally true of fast ECL static RAMs. The 12G014 can perform any combination of read and write cycles in succession with identical 3-nsec cycle timing.

Applications for this type of GaAs IC include cache memory in high-speed computers, data buffers in high-speed fiber-optic communications systems, fast memory for new-generation digital switching equipment, VLSI test and instrumentation equipment, and digital-signal-processing equipment. DARPA (Defense Advanced Research Projects Administration) intends to evaluate the 12G014 for use in an onboard signal-processing application for the SDI program.

TriQuint Semiconductor designed its super-fast TQ6111/TQ6112 8-bit D/A converters primarily as vehicles to test the demand for commercially available GaAs devices. The military will probably be interested in them as well; super-fast D/A converters are needed for fast-frequency-hop transmitters and receivers and arbitrary-waveform synthesizers.

The TQ6111/TQ6112, with their respective 600M- and 1000M-pixel/sec writing rates and standard blanking-interval capability, are naturally suited to high-resolution video displays. Moreover, each device includes a 2:1 input-data multiplexer; the input data rate need be only half that of the D/A output. On-chip ECL references allow easy interface with 10K and 100K ECL circuits. Pricing for the TQ6111-D (in die form) is $159 (100). The faster TQ6112-D costs $259 (100). The devices are available in surface-mount packages and on daughter boards for video and instrumentation applications.

Although Anadigics is designing full-custom and macrocell-based custom GaAs ICs for the military and telecommunications markets, it's also expanding its line of off-the-shelf GaAs products. These include wideband MMICs that operate to 6 GHz; 150-MHz and 350-MHz op amps; and a 2.4-GHz transimpedance amplifier for fiber-optic applications.

Perhaps the most notable of Anadigics's newer standard products is the ACP10010 comparator, a potential building block for high-speed A/D converters. With a propagation delay of 1 nsec, the comparator accepts analog signals to 1 GHz or digital signals to 1G samples/sec. With 20 mV of input overdrive, the propagation delay is 1 nsec; with 100 mV of overdrive, it's only 0.5 nsec.

As a frame of reference, the fastest silicon-based comparators have propagation delays in the 1.5- to 2-nsec range (two to three times slower). Of course, the price/performance tradeoff still exists. The ACP10010 costs $12.95 (1000) in chip form and $19.50 (1000) in an 8-pin plastic flat pack. In similar

quantities, silicon-based comparators cost approximately $6.50 (1000) in chip form and $9.00 (1000) in plastic packages.

Besides its blazing speed, the ACP10010 has another important feature—a proprietary circuit that reduces the otherwise 70-mV hysteresis to zero and ensures glitch-free operation. The IC operates from a standard ±5V supply, has a gain of 100, and has a common-mode input range from +1 to −2V. Because it can drive a 50Ω load to −2V, the ACP10010 is compatible with ECL systems. Its applications include A/D converters, fiber-optic decision circuits, and pin drivers in automatic test equipment.

**Everyone has a MMIC**

Among the many companies supplying MMICs is California Eastern Laboratories, the marketing arm for NEC's semiconductor line. The UPG100 and UPG101 2-stage amplifiers are typical of the wideband MMICs available today. Their operating range is 50 to 3000 MHz.

The two amps have nearly identical internal configurations. The UPG100 is the low-noise version and differs mainly in the size of its FETs. It has a typical noise figure of 2.7 dB, a gain of 16 dB, and a power output of 6 dBm. The UPG101 is the medium-power version and has a noise figure of 5.0 dB, a gain of 14 dB, and a power output of 18 dBm. Pin connections for the two circuits are identical, but with the UPG101 you must use an external choke coil wound on a 100 to 200Ω resistor to properly bias the high-current output stage.

Because both circuits include internal matching to a 50Ω input and output, you can cascade them for additional gain. They are suitable for wideband RF and IF amplifiers. In chip form, the UPG100 sells for $34.50 and the UPG101 for $41.

Microwave Semiconductor Corp (MSC), which is owned by Siemens, recently received DoD approval to participate in classified military defense programs in the same manner as any totally US-owned company. MSC sells GaAs products for fiber-optic applications in the 1.5- to 3-GHz range.

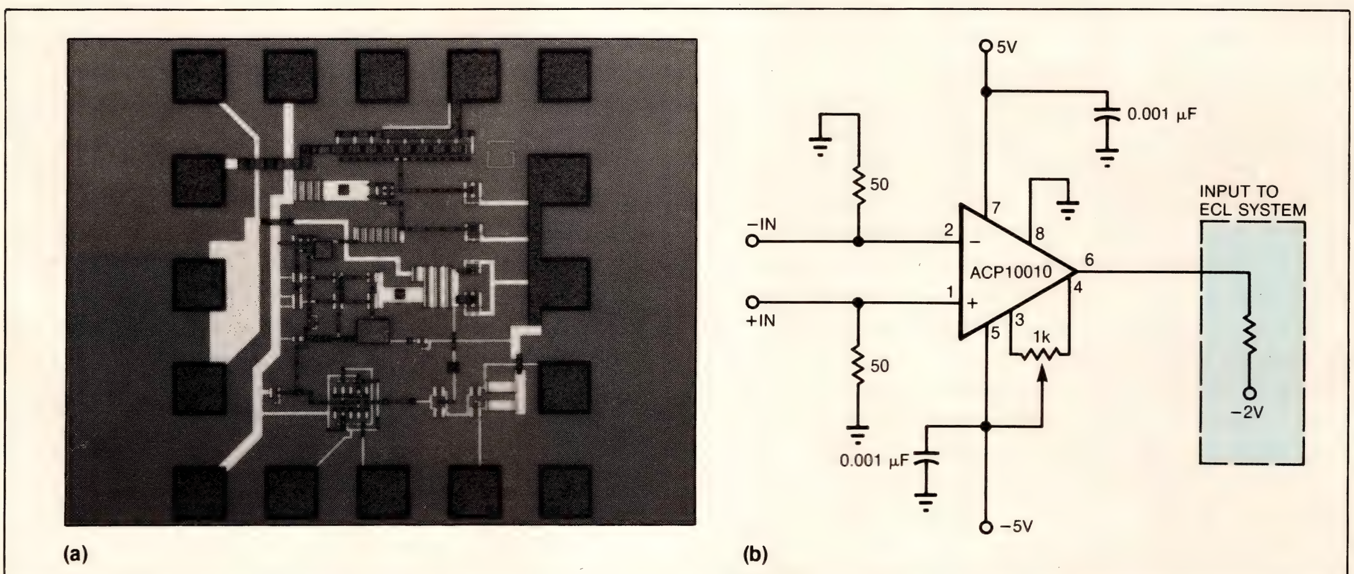
In addition to the fiber-optic ICs, MSC offers wideband GaAs amplifiers for various frequency bands that extend as high as 20 GHz. The company's new D-AMP-110 MMIC amplifier has a useful frequency range from 0.5 to 10.0 GHz and provides a typical gain of 6.5 dB and a power output of 20 dBm across the band. Its typical noise figure is 7 dB, and its gain flatness is ±1 dB.

Applications for this distributed-amplifier chip include EW (electronic warfare) systems, radar receivers and transmitters, and broadband instrumentation such as spectrum analyzers and frequency synthesizers. Chip pricing is $87 (100). The device is also available in a metal-ceramic package.

Ford Microelectronics, a subsidiary of Ford Motor Co, provides IC design and test services for Ford automotive and aerospace activities, but it has recently announced a number of GaAs products available to the merchant market. These include a 600-MHz op amp, a dual-port static RAM with a cycle time of 3 nsec, a serial-to-parallel converter with a 1.8-GHz clock rate, and a 1000-gate gate array.

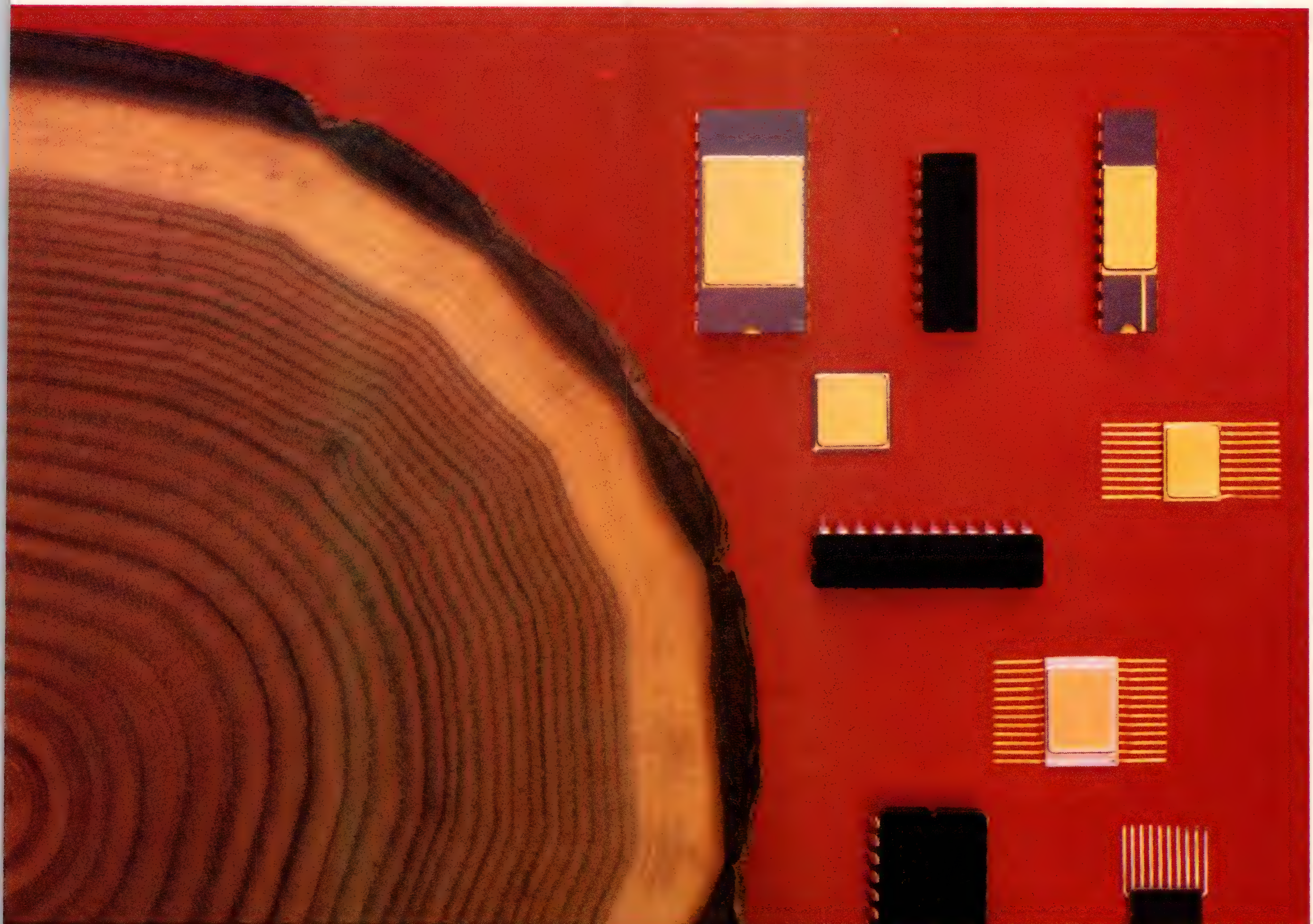
The gate array, dubbed the 21G06, features 561 4-input NOR gates and 100K ECL compatibility. Manufactured with Ford's E/D (enhancement/depletion) self-aligned-gate process, the chip has a typical loaded gate delay of 160 psec when driving three loads and an unloaded gate delay of 100 psec. It typically consumes 0.7 mW per gate.

The 21G06-002 is an 8-bit multiplier originally designed for demon-




***With a 1-nsec propagation delay,*** *the ACP10010 comparator from Anadigics is a potential building block for high-speed A/D converters. The chip layout is shown in* ***a,*** *and a typical circuit connection is shown in* ***b.***

# Bipolar PROMs Through Thick & Thin.



***The Raytheon Commitment.***

☐ **Flexibility.** Matching your requirements for density, screening, and packaging with a broad product line and customer-specific service philosophy. Every part type available with every one of our packages. Every part type available in military and commercial versions. Every part type has Raytheon's proprietary, power-saving SPROM option.

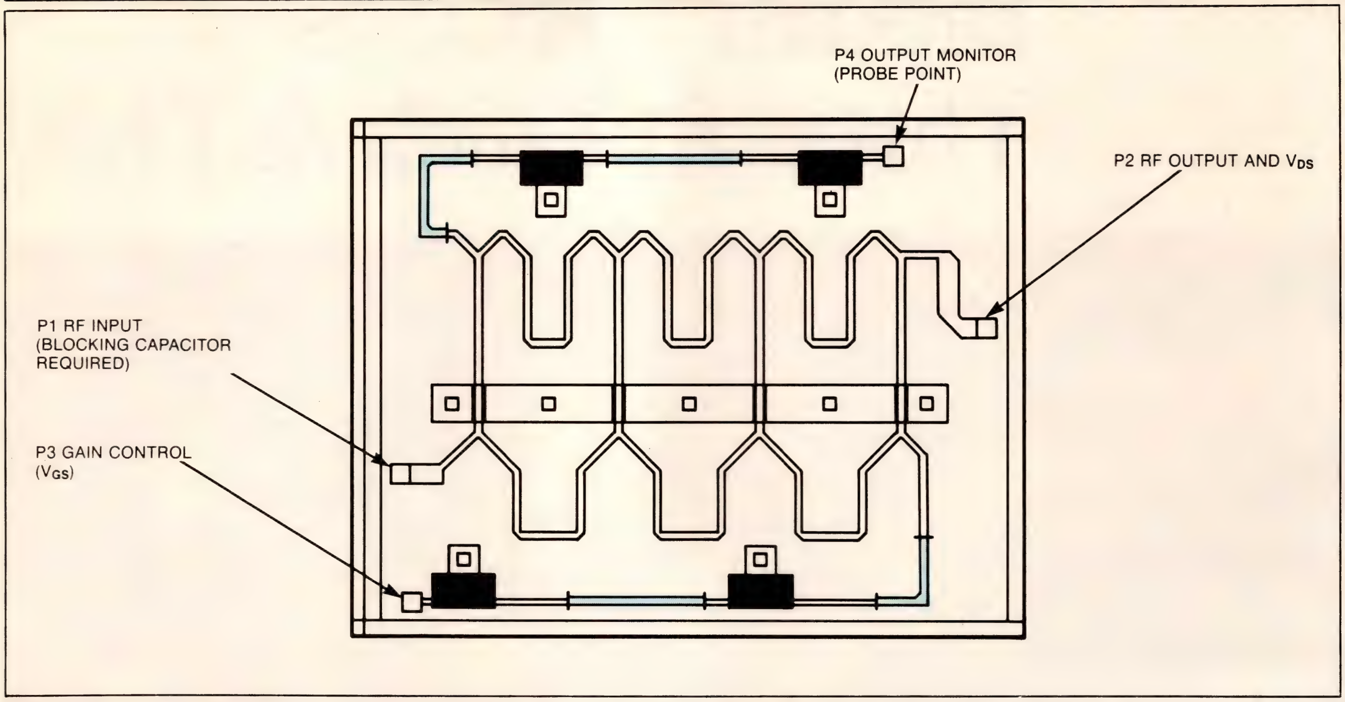
☐ **And Support.** Unmatched commitment to sustain long-term military and commercial programs. Proven in and out of every market cycle.

You need the right bipolar PROMs, and you need them through thick and thin. Call Raytheon. We guarantee you won't be dealing with some shade-tree outfit.

Raytheon Company
Semiconductor Division
350 Ellis Street
Mountain View, CA 94039-7016
(415) 966-7716

***Access to the right technology***

**Raytheon**

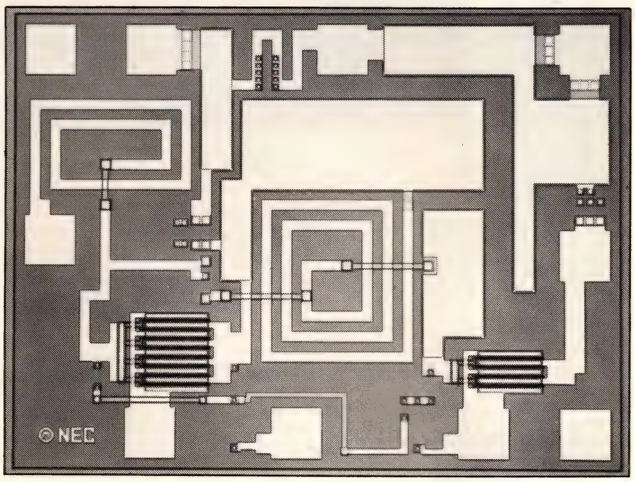


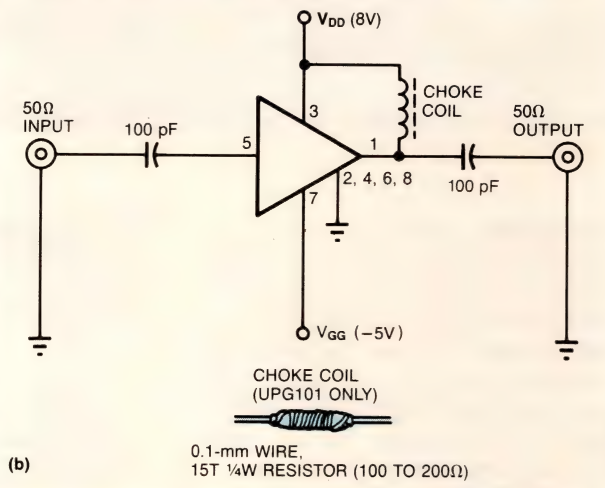

***The D-AMP-110 from** Microwave Semiconductor Corp has a typical gain of 6.5 dB and a power output of 20 dBm. Gate bias is through the separate bias connection (P3) or the RF input port (P1). In either case, the input requires an external dc blocking capacitor. The RF output port (P2) accepts the applied drain bias.*

stration purposes. It uses diode-FET logic, a proprietary process-tolerant circuitry that emphasizes good noise-margin and speed-power performance, and its multiply time is 5 nsec typ. This implementation uses 552 of the possible 561 internal cells for 98% utilization. The 21G06 is packaged in a 48-pin ceramic leadless chip carrier and sells for $540 (100).

Harris Microwave Semiconductor has GaAs products suitable for military and commercial applications. The company is participating in Phase 0 of the DoD's MIMIC (microwave and millimeter-wave monolithic integrated circuit) program and expects to serve as a GaAs foundry for Phase 1 prime contractors. It also provides custom and semicustom services, including a digital standard cell library and CAE support. The present library of 35 cells consists of basic logic functions implemented with buffered FET logic and 2-level metal interconnections.

Besides these custom services, Harris has several GaAs MMICs available as off-the-shelf products. The HMR-10502, based on a 1-μm gate-length process, provides a minimum of 9-dB gain over the range of 0.5 to 5.0 GHz. The HMR-10503 provides a minimum of 9.5-dB gain




***The UPG100 and UPG101 are 50- to 3000-MHz MMICs** from California Eastern Labs (NEC). The UPG100 **(a)** has a noise figure of 2.7 dB and a gain of 16 dB. The UPG101 has a gain of 14 dB and a power output of 18 dBm. The connection diagram **(b)** applies to both circuits.*

# Putting GaAs ICs to work:

## How to make high-speed measurements more accurately.

Let's face it...your measurements are only as good as your timing standard.

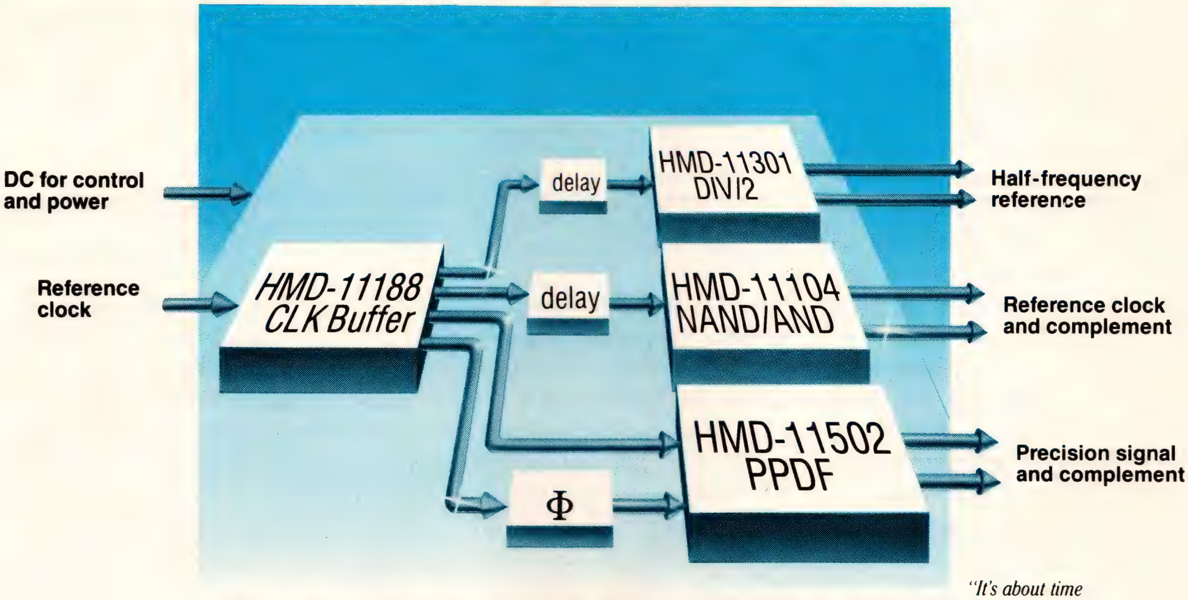
When measuring high-speed ICs, edge placement accuracy is a critical issue. But now, the unique Harris HMD-11502-2 Programmable Pulse Driver/Formatter (PPDF) makes life a little easier. It generates complex pulse trains with independent, variable control of leading and trailing edge placement!

We used our PPDF with other Harris GaAs ICs to build this precision signal generation system for testing our own devices. It's just the ticket for measuring propagation delay, setup and hold times. Edge placement accuracy can be controlled to within 50 picoseconds!

The circuit is configured so that input-to-output propagation delays are equal for all channels. And Φ is a continuous analog phase delay for modifying the PPDF output waveform.

This circuit is a key building block for our high-speed test pattern generator. If it's fast enough for our GaAs ICs, just imagine what it can do for your ECL devices!

For more information, write or call us: Harris Microwave Semiconductor, 1530 McCarthy Blvd., Milpitas, CA 95035. In U.S., phone 1-800-4-HARRIS, Ext. 1510, or (408) 433-2222 (TWX: 910-338-2247). In Canada: 1-800-344-2444, Ext. 1510.




IN GALLIUM ARSENIDE, THE NAME IS

HARRIS

Harris Semiconductor: Analog - CMOS Digital
Gallium Arsenide - Semicustom - Custom

HARRIS






CIRCLE NO 81

over the 1.0- to 5.0-GHz range. Both devices have a noise figure of 7 dB and a power output of 10 dBm. The cost is $29 (1000) for the HMR-10502 and $39 (1000) for the HMR-10503 (in chip form).

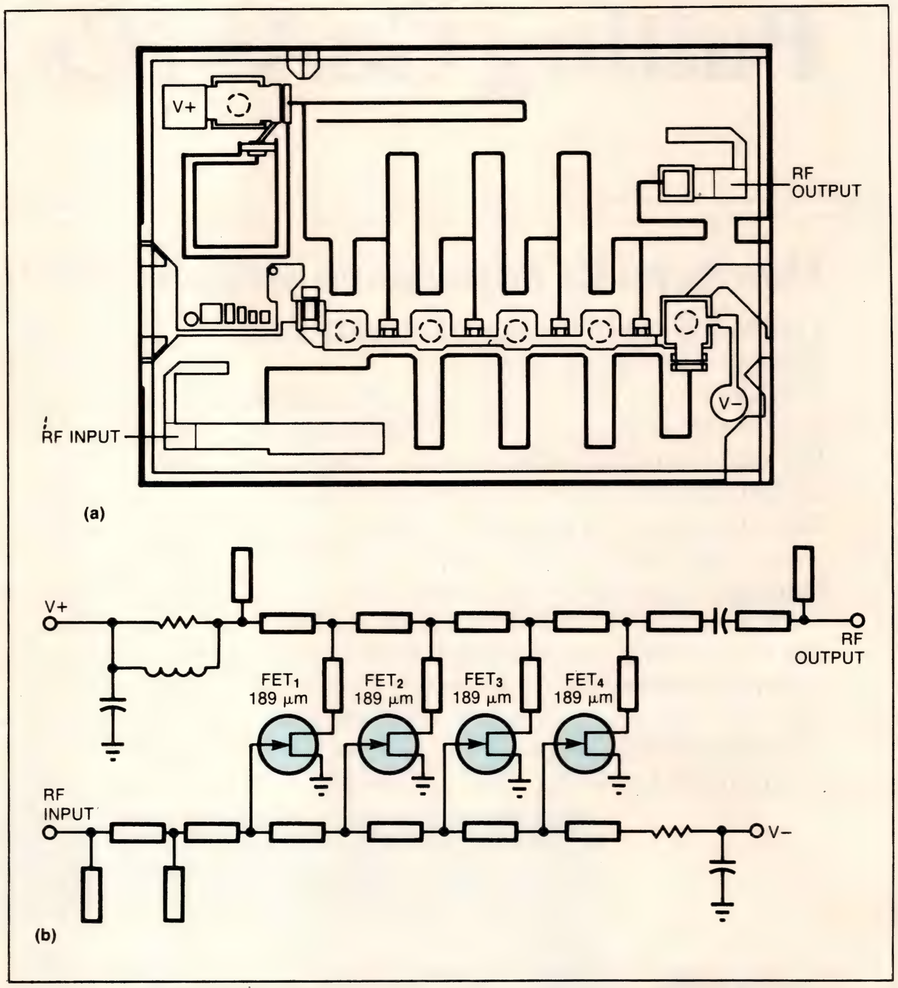
Harris's HMM family of MMICs is fabricated with the same process as its standard 0.5-μm discrete FETs. The HMM-10610 operates over the frequency range of 2 to 6 GHz and has a gain of 12 dB, a power output of 18 dBm, and a noise figure of 6 dB. The HMM-11810 spans the 6- to 18-GHz frequency range and has a gain of 5 dB, a power output of 16.5 dBm, and a noise figure of 6.5 dB. In chip form, the HMM-11810 is priced at $120, and the -10610 costs $42 (1000).

The HMM-10610 is a cascadable MMIC for gain-stage applications where high-frequency broadband performance and superior gain and noise characteristics are major considerations. It fits the 2- to 6-GHz IF band widely used in, for example, EW wideband transceivers for radar warning and jamming. Its 12 dB of gain is flat within ±0.5 dB over the entire frequency range, and its 6-dB noise figure is measured at 120 mA. You can bias each of the two gain stages independently to achieve optimum noise, gain, or power.

This amp requires only one power supply and includes integral bias-bypass and source-bypass networks. Depending on the supply voltage (5 to 9V) and the connection chosen for the source-resistor bias network, you can program the gain from 9.5 to 13.5 dB and the power output from 15 to 21 dBm.

Texas Instruments, a long-time supplier to the military market with its silicon-based products and GaAs foundry services, has only recently begun to manufacture GaAs standard products for the merchant market. In addition to discrete FETs, the company sells several MMICs that operate in the microwave range.

The TGA8035, a general-purpose amplifier suitable for use in the 6- to 18-GHz range, features 12-dB gain and low noise. The TGA8014 is a power amplifier with a typical gain of 8 dB and a high-power output of 0.5W. For X-band operation, the TGA8021 low-noise amplifier has a gain of 24.5 dB typ and a noise figure of 2.4 dB typ. The TGA8024 dual-gate driver amplifier has both high gain (30 dB) and high-power output (0.5W). Prices are as follows: TGA8035, $75; TGA8014 and TGA8021, $145; TGA8024, $325 (1000).




***Operating over 2 to 18 GHz,** this 4-stage distributed amplifier from Texas Instruments has a gain of 6.5 dB and a power output of 18 dBm. The chip layout is shown in **a**, and the circuit topology is shown in **b**. The amp typically uses a 6V supply and a −1V supply.*

### A really broadband MMIC

The newest GaAs monolithic amplifier from TI is the TGA8300. This 4-stage distributed amplifier operates over 2 to 18 GHz and is intended for use as a very broadband general-purpose gain block. Four 189-μm gate-width FETs provide 6.5-dB nominal gain, a noise figure typically under 6 dB over most of the frequency range, and a power output of 18 dBm. The SWR at both the input and output is less than 2:1. During normal operation, the circuit operates from a 6V supply and a −1V supply. It sells for $97 (1000).

Celeritek, a relative newcomer to the GaAs IC field, produces MMICs, hybrid microwave amplifiers, and amplifier-based systems for delivery to prime defense contractors, and it now offers three types of MMICs as standard products. The CMM-2 and CMM-5 both operate over the 2- to 6-GHz band but have different gain, power output, and current drain characteristics. The CMM-4 has an extended range of 2 to 18 GHz.

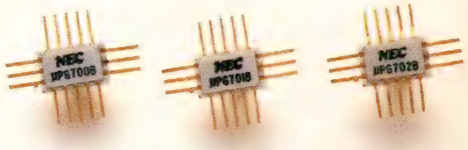
# ECL Compatible GaAs Digital ICs

Operating at a 2.4 Gbps clock rate, these three new NEC GaAs Digitial ICs each perform different functions:

**Master/Slave D Flip Flop—UPG700B**
**Master/Slave T Flip Flop—UPG701B**
**3 Input OR/NOR Gate—UPG702B**

The 700 and 701 have set/reset capability and all three are fully ECL compatible. Not just in I/O levels, but in supply voltages too. So you can include them with ECL components without additional design. Reliability of operation has been ensured by tungsten silicide refractory gate metallization.

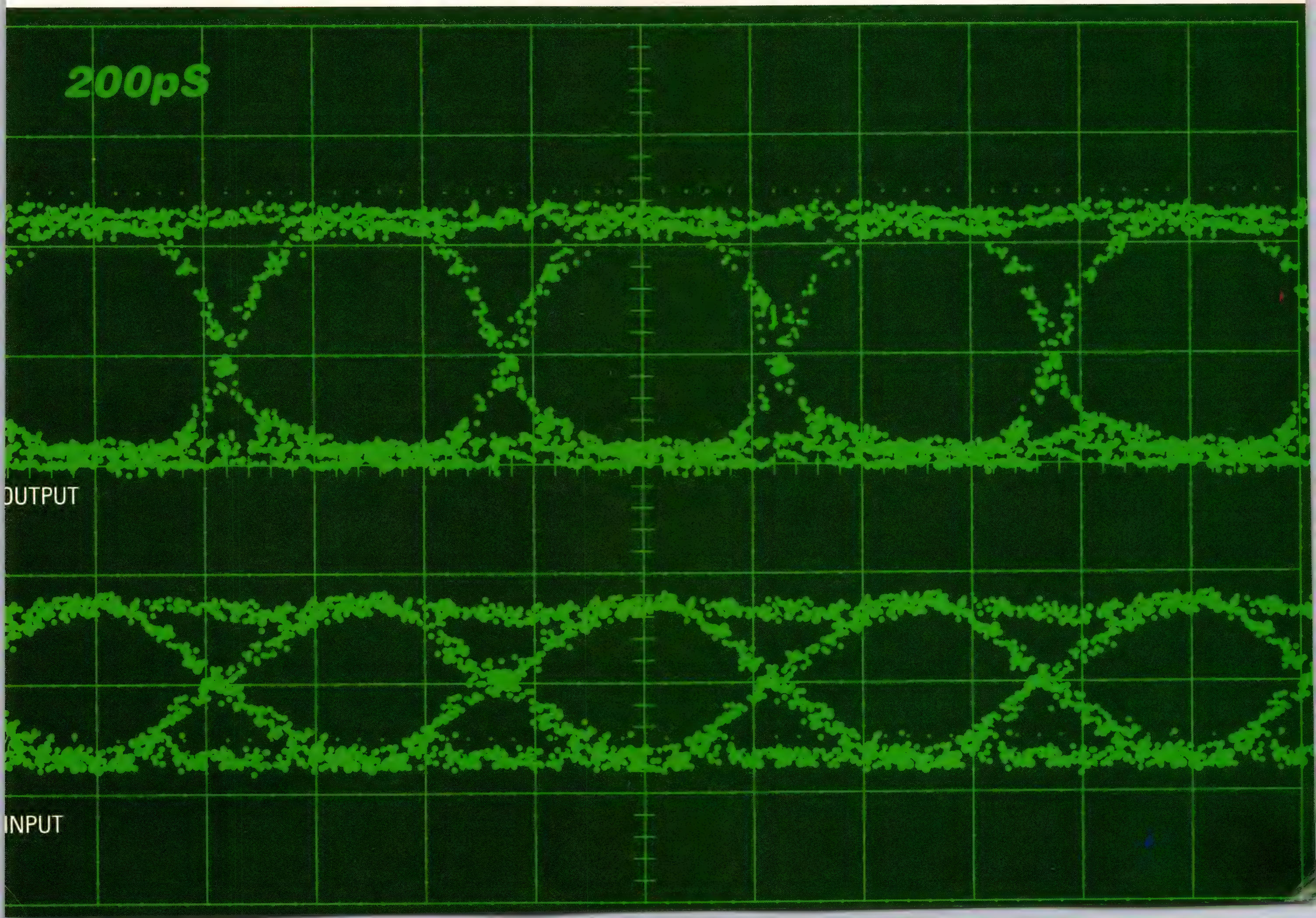
All ICs are designed to meet the high speed data requirements of fiber optic systems, test instrumentation and other digital signal processing for space, military and industrial applications. Call for our new data sheets, application note, price and delivery.

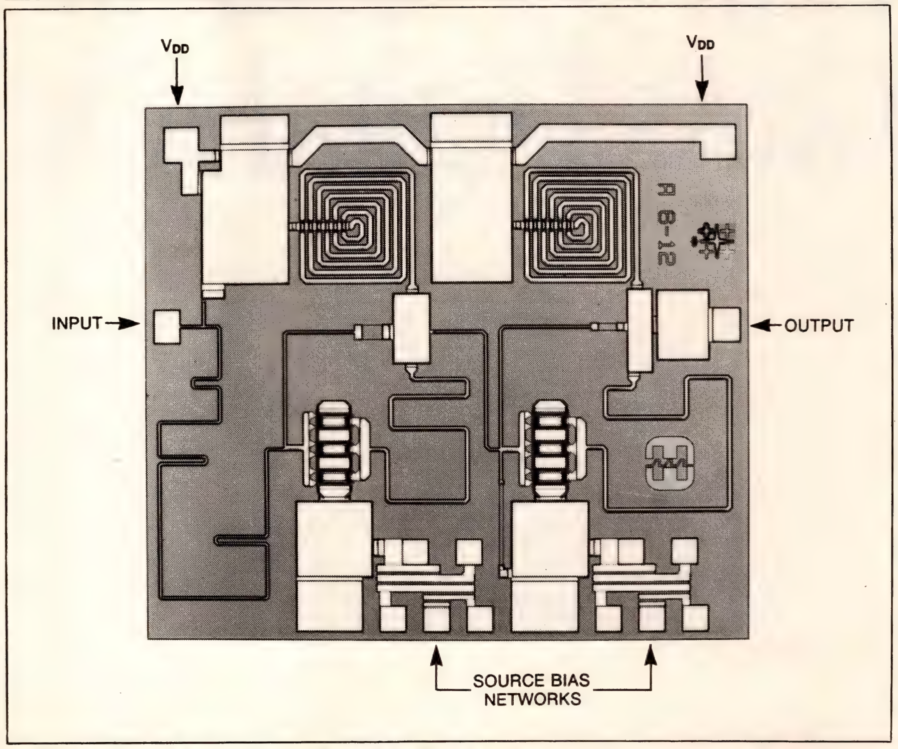



California Eastern Laboratories
3260 Jay Street, Santa Clara, CA 95054 (408) 988-3500
**Western** (408) 988-3500 **Eastern** (301) 667-1310
**Canada** (613) 726-0626
**Europe** NEC Electronics GmbH 0211/650301

NEC®
NEC Corporation

CIRCLE NO 80






***The HMM-10610 fits the 2- to 6-GHz IF band widely used in military applications.*** *Its typical 12-dB gain is flat within ±0.5 dB over the entire frequency range. It is cascadable and needs only one power supply, and its power output and gain are programmable.*

The CMM-5 has a gain of 16 dB, a power output of 15 dBm, and a noise figure of 6 dB. The CMM-2 has a gain of 10.5 dB, a power output of 8 dBm, and a noise figure of 5.8 dB. The CMM-2 biases its two amplifier stages in series to achieve a current drain about one-third that of the CMM-5. The CMM-4 has a gain of 7 dB and a power output of 16 dBm. Pricing in 1000-piece quantities is $60 (CMM-2), $65 (CMM-5), and $100 (CMM-4). **EDN**

Article Interest Quotient
(Circle One)
High 512 Medium 513 Low 514

## For more information . . .

For more information on the GaAs ICs discussed in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

**Anadigics**
35 Technology Dr
Warren, NJ 07060
(201) 668-5000
TWX 510-600-5741
**Circle No 641**

**California Eastern Laboratories**
3260 Jay St
Santa Clara, CA 95054
(408) 988-3500
TLX 346393
**Circle No 642**

**Celeritek**
617 River Oaks Parkway
San Jose, CA 95134
(408) 433-0335
TLX 171728
**Circle No 643**

**Ford Microelectronics Inc**
10340 State Highway 83 N
Colorado Springs, CO 80908
(303) 528-7660
**Circle No 644**

**GigaBit Logic**
1908 Oak Terrace Lane
Newbury Park, CA 91320
(805) 499-0610
TLX 6711358
**Circle No 645**

**Harris Microwave Semiconductor**
1530 McCarthy Blvd
Milpitas, CA 95035
(408) 433-2222
TWX 910-338-2247
**Circle No 646**

**Microwave Semiconductor Corp**
100 School House Rd
Somerset, NJ 08873
(201) 563-6300
TLX 833473
**Circle No 647**

**Texas Instruments Inc**
Microwave Military Components
Box 655474, M/S 402
Dallas, TX 75265
(214) 995-3043
**Circle No 648**

**TriQuint Semiconductor**
Group 700, Box 4935
Beaverton, OR 97075
(503) 629-3535
TLX 151754
**Circle No 649**

# Now! 100 MHz. Cursors. CRT readout. Four channels. All for just $2400.

**The NEW Tek 2246 and 2245 set the pace in fast, accurate measurement. And immediate, easy delivery.** Take a close look. At their unmatched price/performance. At versatile, on-site/at-bench convenience. At Tek SmartCursors,™ a 2246 exclusive. All backed by a 3-year warranty and 30-day free trial on approved credit. Don't settle for less. Get out in front with scopes that set the pace. Return the card or call Tek direct:

**1-800-433-2323**
Or call collect
**(503) 627-9000**

VISA
MasterCard

| Features | 2246 | 2245 |
|---|---|---|
| Bandwidth | 100 MHz | 100 MHz |
| No. of Channels | 4 | 4 |
| SmartCursors™ | Yes | No |
| Time/Volts Cursors | Yes | No |
| Voltmeter | Yes | No |
| Scale Factor Readout | Yes | Yes |
| Vertical Sensitivity | 2 mV/div | 2 mV/div |
| Max. Sweep Speed | 2 ns/div | 2 ns/div |
| Accuracy: Vert/Hor | 2%/2% | 2%/2% |
| Warranty | 3-year on parts and labor, including CRT | |
| Price | $2400 | $1775 |


1 SmartCursors™ track trigger level, ground level or peak voltages. 2 CRT readout of scale factors and results. 3 Menu functions controlled by top row of push-buttons. 4 Gated voltage mode intensifies the portion of a waveform on which voltage measurements are being made. 5 Versatile triggering lets you trigger the main or delayed sweep. 6 Back-lit control buttons.

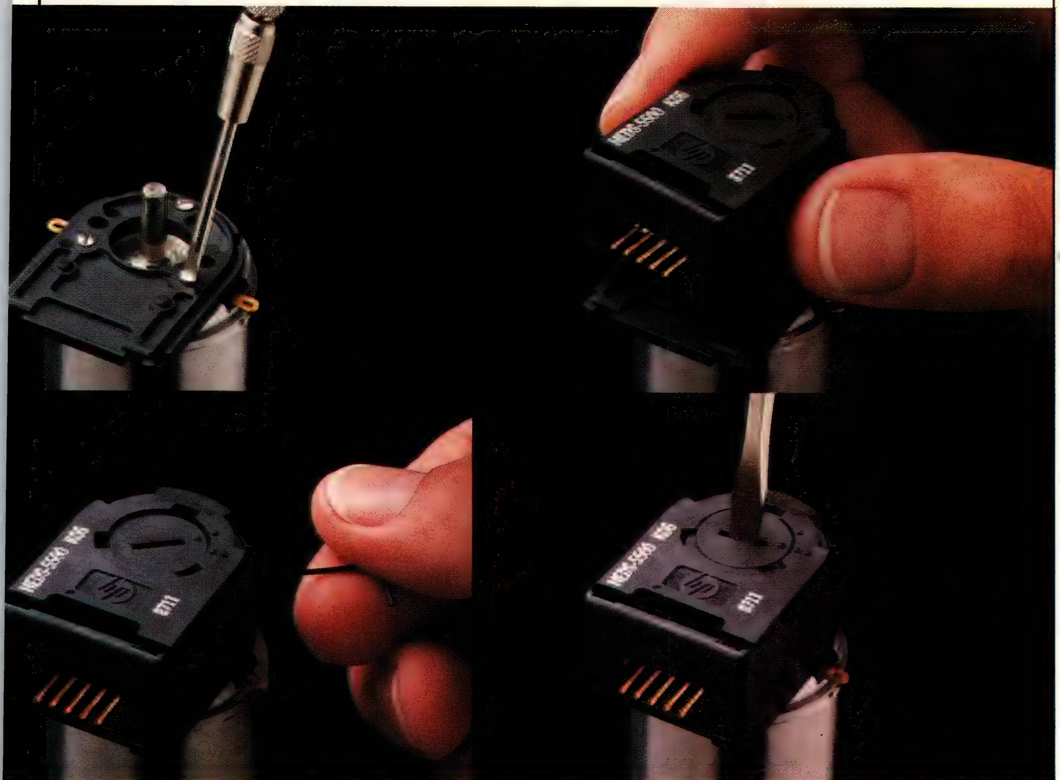
**Tektronix®**
COMMITTED TO EXCELLENCE

**CIRCLE NO 110**

# *Twist.*
# *Snap.*
# *Twist. Twist.*
# *An encoder with a difference.*

*we never stop asking*

*"What if..."*



Up to 240 times an hour! It takes as little as 15 seconds to install Hewlett-Packard's new, HEDS-5500 optical encoder. That's completely installed, aligned, ready to go with baseplate, housing, code wheel, encoder module—and no gluing.

That's not all. At prices as low as $25‡ apiece in 1000 quantities, it's also one of the lowest-cost encoders you can buy.

At its heart is the award-winning HEDS-9100 optical encoder, a favorite among those building custom encoders since its introduction last year. Code wheel resolutions from 96 to 512 are available. Shaft diameters from 5/32″ to 1/4″ can be accommodated.

In short, it's a complete, simple, quick solution, with the potential to increase the productivity of your assembly line.

**See this newest twist for yourself!**

Take a turn with our newest encoder and you'll soon see why we think this is such an exciting new product. To get your sample,* send this coupon, a check made out to Hewlett-Packard Company for $7.00, *and your business card* to Monte Smith, Mail Stop 91-1G, Hewlett-Packard Components Group, 370 West Trimble Rd., San Jose, CA 95131. Offer good for 90 days. One to a customer, please!

*Check one: ☐ A. 500 counts per revolution, ¼″ shaft diameter
☐ B. 360 counts per revolution, ¼″ shaft diameter

EDN 082087 CG08708

To order, contact your nearest HP distributor. In the U.S.: Almac Electronics, Hall-Mark, Hamilton/Avnet, or Schweber. In Canada: Hamilton/Avnet or Zentronics Ltd. ‡U.S. list price.

CG08708

HEWLETT PACKARD

CIRCLE NO 108

# Experience EZ-PRO.


Experience quick delivery, easy operation, fast development schedules. EZ-PRO® users reap the benefits of the C language fully integrated with advanced emulation tools, including precedence triggering, Deep Trace,™ and on-line code revisions.

In addition to IBM® PC-XT/AT, hosts include IBM Personal System/2,™ Macintosh II,™ VAX,™ MicroVAX,™ and Sun Workstation.®

EZ-PRO users also have the advantage of the best post-sales support in the industry.

They know that their emulators are covered by American Automation's 5-year limited warranty.

And the cost? EZ-PRO development support, both hardware and software, for 64180 projects—less than **$2,800**. Same for 8051. The 68HC11—**$4,495.***

Experience EZ-PRO for your next project.

| **Intel:** | | **Motorola:** | | **Hitachi:** | **Rockwell:** | **RCA:** | **Zilog:** |
|---|---|---|---|---|---|---|---|
| | 8031 | | 6800 | 6301R | 6502 | 1802 | Z80A |
| | 8032 | | 68B00 | 6301V1 | 6503 | 1805 | Z80B |
| 8086 | 8035 | 68HC11A2 | 6801 | 6301X | 6504 | 1806 | Z80H |
| 8088 | 8039 | 68HC11A8 | 6802 | 6301Y | 6505 | CDP6805C4 | Z180 |
| 80186 | 8344 | | 68B02 | 6303R | 6506 | CDP6805C8 | Z8001 |
| 80188 | 8048 | 68000 | 146805E2 | 6305V | 6507 | CDP6805D2 | Z8002 |
| 80286 | 8049 | 68008 | 6803 | 63705 | 6512 | CDP6805E3 | |
| | 8050 | 68010 | 6808 | 6309 | 6513 | **Harris:** 80C86 | **NEC:** V20 |
| | 8051 | | 68B08 | 6309E | 6514 | 80C88 | V30 |
| | 8085A | | 6809 | 64180R | 6515 | **National:** | **Signetics:** 8X300 |
| | 8085A2 | | 6809E | | | NSC800 | 8X305 |
| | 8096/97 | | 68B09 | | | | |
| | | | 68B09E | | | | |

**...AND MORE**

*Assumes EZ-PRO Development Station connected to MSDOS host.

**american automation**

2651 Dow Avenue, Tustin, California 92680 **(714) 731-1661**
Telex II: 910-595-2670 AMAUTO TSTN • FAX: 714/731-6344



**CIRCLE NO 106**

# CASE tool kits tailor DoD-STD-2167 requirements for software documentation

Margery S Conner,
*Regional Editor*

Proponents of computer-aided software engineering packages make optimistic claims for CASE's ability to streamline the analysis and design of large-scale software projects. However, skeptics caution that, in the same way that software innovation always lags behind hardware innovation, so too does the capability of CASE packages lag behind that of the already entrenched hardware CAD/CAE packages. However, one area in which you can immediately apply CASE is the documentation of large software projects, particularly when the documentation form is clearly specified—as it is in DoD-STD-2167.

***You can develop Ada documentation*** *and code with the Rational R1000 development system. Of the available CASE packages, the Rational 1000 does the most nearly complete job of integrating system documentation into the software development environment—but at a hefty price.*

Although it's theoretically possible to develop a large-scale program (say, upwards of a million lines of code) without documentation, practically speaking it would be almost impossible to ensure both its quality and maintenance. DoD-STD-2167 specifies the documentation that must accompany mission-critical software for the military: For each phase of software development, you must document design constraints, quality factors, and test procedures.

### Standard is tailorable

However, not all programs must slavishly follow the standard. For mission-critical programs, you'll have to see that all requirements are satisfied, but most military software is not mission-critical.

James Brelsford, software quality-assurance engineer at Lockheed (Burbank, CA), recommends that you think of the standard as a list of potential requirements that you can tailor to suit your application. For example, the standard specifies a System Requirement Specification (SRS) as well as an Interface Requirements Specification (IRS). For a program that's not mission-critical, such as a test program, you may well be able to combine the IRS into the SRS and save a document. Remember, part of the expense involved in military projects is the maintenance of documentation. Over the long run, any documentation not generated can mean a significant cost savings. (Of course, any tailoring of the standard must be negotiated with the customer.)

Brelsford points out that there are currently very few experts in 2167. He looks forward to the day when an expert system computer program will guide engineers through the 2176 tailoring process. But he cautions that that capability is still several years off.

The initial step in software analysis is software requirements analysis. The bulk of this analysis consists of manually or automatically searching the system definition for the word "shall." "Shall" signals that what follows must be accomplished by the software and must be documented in the system requirements specification.

The most important capability your CASE package can give you is requirement traceability—the ability to display a requirement at the SRS level and follow its development down to the detail design level to verify that code exists to support the requirement.

Nastec and Rational offer CASE tools to support this decomposition of the requirements, but the two approaches are at opposite ends of the price spectrum.

Nastec's DesignAid searches the system definition and automatically flags the "shalls." (Although DesignAid is the only package that incorporates this search capability, it's a relatively straightforward task to write your own search program for any of the other manufacturers' CASE tools.) For each "shall" it

*"A CASE for SUN in Computer-Aided Engineering"*

It's a first! CASE Technology now offers its new Vanguard CAE Design System, a comprehensive set of electronic design applications for the system level designer—PCB and ASIC—on the SUN 3 family of engineering workstations. The system includes schematic capture, logic and fault simulation, circuit simulation, and PCB design capabilities.

The full-featured Vanguard system and the SUN 3 workstation represents one of the best values available for a high performance CAE design system. Using Ethernet TCP/IP and NFS, SUN 3 engineering workstations and personal computers can be networked together to create a completely integrated engineering environment.

CASE promotes its flexibility as a front-end CAE design tool for users concerned with integration of existing tools and as a facility solution for those interested in a single source for all of their CAE needs.

With more than 3000 installed systems worldwide, CASE Technology has developed a solid reputation as a premier supplier of professional CAE design tools. If you haven't seen what CASE has to offer, then now is the time.

CASE Technology Inc., 2141 Landings Drive, Mountain View, California 94043
Phone (415)962-1440; Telex 506513;
FAX (415)962-1466.

**CASE TECHNOLOGY**

CIRCLE NO 105

finds, DesignAid assigns an object type name (Requ1, Requ2, . . . Requn) and defines it as a requirement.

Requirements are one of the object types that are defined in DesignAid's dictionary; examples of some other object types are processes or data. You also have the option of making up your own object type and defining what its attributes are. For example, if you defined an object type "requirement" with the attribute "radar," you could later ask for a report listing all

## An alternative to the waterfall method

Documentation that satisfies DoD-STD-2167 should not only ensure the software's compliance to the customer's specifications, it should also give the customer a better view of the software's development. Horror stories exist of software projects for which customers weren't shown any results of the code until it was too late for them to provide any feedback.

The most common software development path, shown in **Fig A**, is the waterfall. In this method, each step is fully completed before the next one begins. This method may let you progress too far in your software development before you receive any feedback from the customer.

Lockheed's James Brelsford suggests that a program-development method developed in artificial intelligence—called rapid prototyping—might promote early feedback from the customer to the contractor. Instead of the linear process of the waterfall approach, rapid prototyping places emphasis on having something to show the customer. You can leave one of the development steps before you've completed it in the interests of getting a prototype out for the customer to critique.

Howard Yudkin, president of the industry-sponsored Software Productivity Consortium, refers to the method simply as prototyping. He cautions, "Most of the 'rapid prototyping' that I see is generation of user screens."

Yudkin stresses that prototyping is not a revolutionary concept; after all, it's common in hardware design to prototype prior to the final design. He adds that as software increases in complexity, it's unreasonable to expect engineers to be able to perform a complete design at an abstract level. Software prototyping should result in a shorter design time and closer adherence to the customer's needs.

Prototyping has a drawback, however. Documentation is difficult to keep current. As you complete each step in the waterfall approach, the documentation is completed and subsequently changes very little. Because in software prototyping the implementation of each step will change many times, the documentation must also. And you can't wait until the software is completed and then document after the fact, because by then it's too late. This method's drawback is that documentation will account for a sizable amount of your resources, and it requires documentation to be done many times.

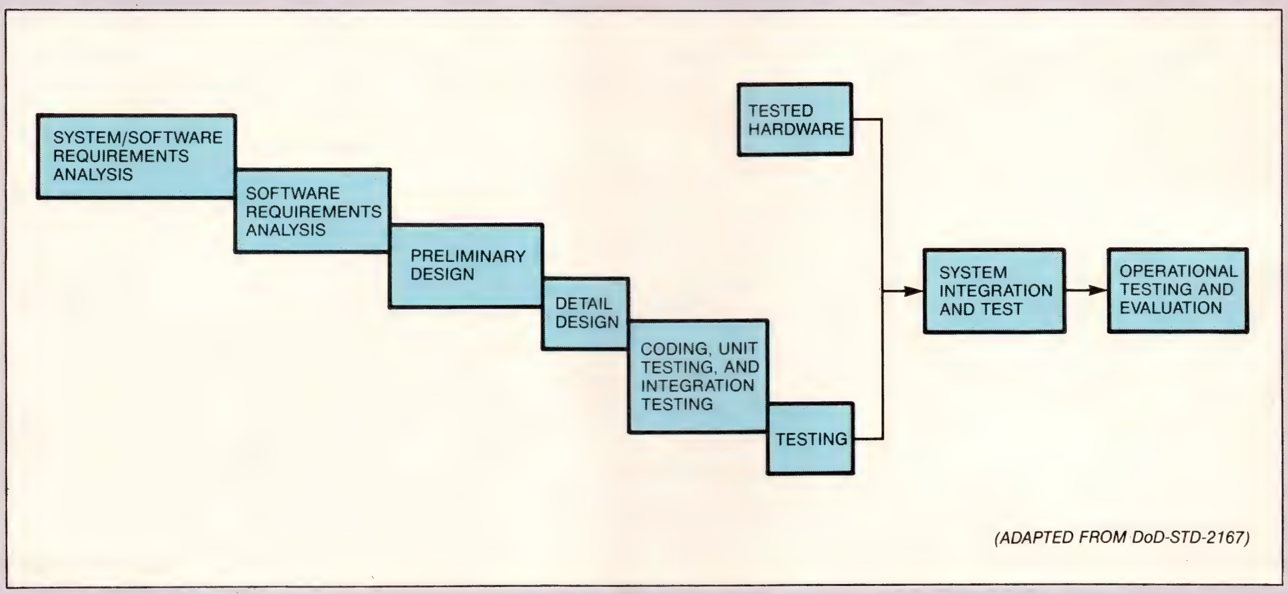



***Fig A—The waterfall method*** *of software development is the most popular, but it might let you spend too much time on the wrong implementation before receiving customer feedback.*

requirements that are radar-related.

DesignAid lets you trace the software's support of the requirements by selecting each requirement's name (which serves as the file name for related information) and decomposing it—that is, pulling up the next level of detail. For example, when you select a requirement's name and decompose to the next level, DesignAid will display the module of the data-flow diagram (DFD) that supports the requirement. Decomposing that DFD module will show its detail design level, and the detail design decomposes to the actual code.

Upwards traceability is not as simple, because a single piece of code may support multiple requirements; you must leave a trail detailing where you've been. DesignAid lets you build a menu to select which of the multiple upwards paths you wish to take to trace to a particular requirement.

DesignAid runs on the IBM PC/XT, PC/AT, and compatibles, as well as on the VAXstation II.

Rational's CASE system, the R1000 development system, consists of the company's software running on its proprietary workstation, the Rational Series 100 and 200. As you might expect, the Rational 1000 has a considerably higher price tag than CASE tools consisting only of software: The basic system prices range from $295,000 to $795,000. Keep in mind that documentation is a by-product of the Rational environment; the environment's main focus is on defining the software system's structure, specifying and creating components, building system releases, and conducting system tests.

**Full 2167 support**

The system was developed specifically for the military market, and it shows: The system offers by far the greatest degree of hands-off 2167 documentation generation. For example, in the requirements-analysis phase of the software design lifecycle, the Rational system generates the SRS. For the preliminary design phase, which consists of analyzing the top-level software modules, the Rational system generates the software top-level design document, or STLDD (**Fig 1**). At the detail design level, which consists of defining the lower-level software components, the system generates the software detail design document (SDDD).

As a result of defining the top-level computer-system components (TLCSC) for the STLDD, you'll end up with a TLCSC allocation table, which enables you to trace a requirement both to its TLCSC name and to the paragraph in which it

### 3.6 Top-Level Design

3.6.1 CRUISE_CONTROL TLCSC
- Purpose
  This package defines all the visible interfaces to the entire Cruise Control CSCI. All of the interfaces identified in section 3.3 of the SRS are included in this package. This includes CSCI-to-HWCI interfaces as well as CSCI-to-CSCI

- States
  (MANUAL, CRUISE, ACCELERATION, DECELERATION)

3.6.1.1 Inputs
NONE

3.6.1.2 Local Data
NONE

3.6.1.3 Interrupts
- WHEEL_ROTATION
  Interrupt triggered each time the hardware detects one revolution of the wheels. Used for computing current speed. Frequency of interrupt ranges from 0 Hz to 25 Hz.

- OPERATOR_COMMAND
  Interrupt triggered by the hardware when the operator enters any command for the cruise control system.

- CLOCK
  Periodic interrupt occurring every 2msec. The interrupt provides a status word containing the brake activation status and the accelerator activation status.

3.6.1.4 Timing and Sequencing

3.6.1.5 Processing

3.6.1.6 Outputs
NONE

(COURTESY RATIONAL)

*Fig 1—**This system top-level design document** (STLDD) defines the requirements for a sample cruise-control software package. Each entry is a top-level computer-system component (TLCSC).*

### 3.2 Functional Allocation

TLCSC Allocation Table

| Requirement | TLCSC Name | SRS Paragraph |
|---|---|---|
| THROTTLE DATA Interface | CRUISE_CONTROL | 3.3.3.1.1 |
| CRUISE STATUS Interface | CRUISE_CONTROL | 3.3.3.1.2. |
| WHEEL ROTATION Interface | CRUISE_CONTROL | 3.3.3.2.2 |
| OPERATOR COMMAND Interface | CRUISE_CONTROL | 3.3.3.2.1 |
| CLOCK Interface | CRUISE_CONTROL | 3.3.3.2.3. |
| CURRENT SPEED Function | VEHICLE_DYNAMICS | |
| CRUISE SPEED Function | VEHICLE_DYNAMICS | |
| THROTTLE DATA Function | VEHICLE_DYNAMICS | |

(COURTESY RATIONAL)

*Fig 2—**This TLCSC allocation table** cross references the requirement name to its TLCSC name and to the system requirement specification (SRS) paragraph in which it's defined.*

# 1 Discover the Power of Integrated CAE Design Capture and Verification.

**IN A SERIES**

Tektronix Aided Engineering

Finding the most powerful electronic design solutions is now easier than ever, thanks to the Designer's WorkSystem.™

Developed by Tektronix as part of Tektronix Aided Engineering, the Designer's WorkSystem combines design capture and verification tools into one powerful solution.

Designer's Database Schematic Capture (DDSC™) provides you with a fast, user-customizable, menu-driven system for design capture of IC and PCB schematics.

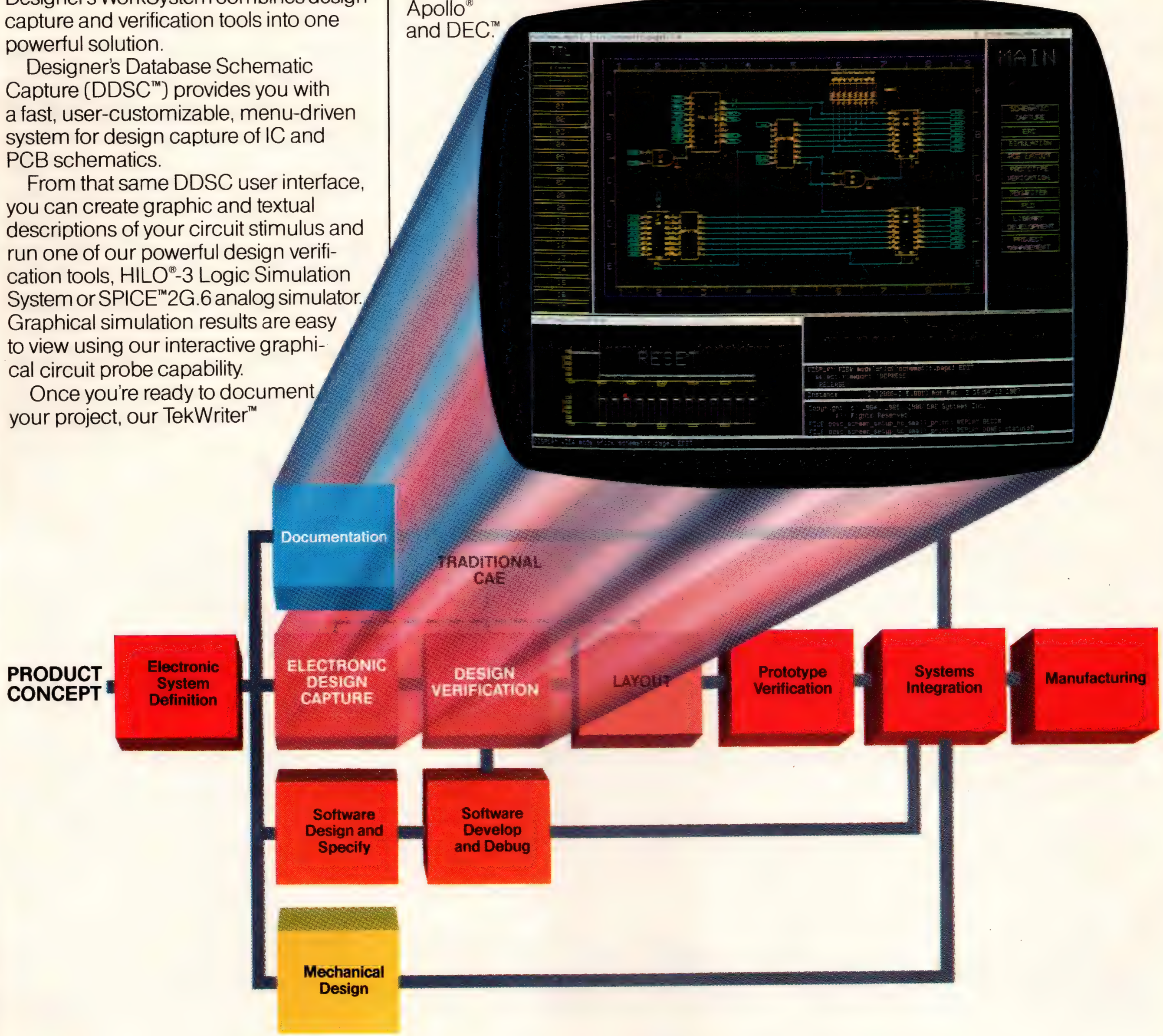
From that same DDSC user interface, you can create graphic and textual descriptions of your circuit stimulus and run one of our powerful design verification tools, HILO®-3 Logic Simulation System or SPICE™2G.6 analog simulator. Graphical simulation results are easy to view using our interactive graphical circuit probe capability.

Once you're ready to document your project, our TekWriter™ Engineering Design Documentation System (based on Interleaf™) lets you merge DDSC design schematics and simulation data with professional text formats and other graphics for fast, camera-ready documentation.

It's all part of Tektronix Aided Engineering. A family of integrated WorkSystems addressing each area of your electronic design cycle. From design capture, verification and documentation to IC and PCB layout. All running on industry-standard platforms from Apollo® and DEC.™

Best of all, it's from Tektronix. The name you've always trusted to get the engineering job done. So you're assured of worldwide service, support and training.

To discover the power of Tektronix Aided Engineering, contact your local Tektronix, CAE Systems Division, sales office. Or call 800/547-1512. Tektronix, CAE Systems Division, P.O. box 4600, Beaverton, OR 97076.




WorkSystem, DDSC, TekWriter are trademarks of Tektronix, Inc. HILO is a registered trademark of GenRad, Inc. SPICE is based on Berkeley SPICE, University of California at Berkeley Interleaf is a trademark of Interleaf, Inc. Apollo is a registered trademark of Apollo Computers, Inc. DEC is a trademark of Digital Equipment Corporation

**Tektronix®**
COMMITTED TO EXCELLENCE

CIRCLE NO 103

appears in the SRS (**Fig 2**). Note that although 2167 requires documented traceability only in the form of the TLCSC allocation table, you'll find it useful to be able to interactively request the CASE tools for requirements traceability.

Promod offers this capability in its compliance matrix option ($500 for PC-based systems; $1000 for VAX-based systems). The standard Promod package can generate stand-alone cross-reference reports for cross referencing items and objects to minispecifications, modules, and functions.

The last phase is that of detailed design, which consists of defining the lower-level computer software components (LLCSC) and results in the SDDD. Some of the CASE tools, such as the ones from Rational, Promod, Cadre, and Index, can generate code, based on a program description language that you develop the LLCSCs in. The packages support Ada, the high-level language the military has mandated.

However, Ira Levin, a senior staff engineer for Hughes Ground Systems Group (Fullerton, CA), points out that much military software is in firmware, and you may need to develop code in assembly language. None of the packages he has seen so far support decomposition from the requirements level to the assembly-code level.

In fact, although his group uses CASE tools to ease both software development and documentation generation, he feels that CASE tools have a long way to go to fully support both activities. He predicts that the CASE tools you initially select, perhaps just to familiarize yourself with the technique, will not be the same package that ultimately becomes useful. That package, he surmises, has probably not been developed yet.

Extensibility in a CASE package refers to your ability to modify the basic set of tools to best fit your application. Cadre's Teamwork package comes with the Access option. After modeling your application with the Teamwork set of structured-analysis and -design tools, you can write a C program to handle functions that Teamwork does not specifically support, such as automatic generation of DoD-STD-2167 reports. (You can write the programs in another language, but you'll have to translate Access's C include file into that language.) You can then link your program with the Access run-time library.

If you have included in your database information such as references to related documents or timing or test-plan requirements, you can attach these notes to objects in the database via Access. Teamwork also provides links to documentation-production systems like PicED from Context (Beaverton, OR) or WPS/TPS from Interleaf (Cambridge, MA).

Excelerator from Index Technolo-

## TABLE 1—CASE TOOLS THAT CAN SUPPORT DoD-STD-2167 DOCUMENTATION REQUIREMENTS

| VENDOR | CASE PRODUCT | HARDWARE SUPPORTED | PRICE RANGE | NOTES | CIRCLE NO |
|---|---|---|---|---|---|
| **CADRE TECHNOLOGIES INC** 222 RICHMOND ST PROVIDENCE, RI 02903 (401) 351-5950 | TEAMWORK/RT, TEAMWORK/SA, TEAMWORK/SD, TEAMWORK/IM, ACCESS | APOLLO (FULL LINE) VAXSTATION II RT PC SUN-3 & SUN-2 | FROM $7500 PER MODULE; ACCESS COSTS $900 | TEAMWORK/RT,/SA,/SD, AND /IM SUPPORT REAL-TIME, STRUCTURED ANALYSIS, STRUCTURED DESIGN, AND INFORMATION MODELING, RESPECTIVELY. | 704 |
| **INDEX TECHNOLOGY CORP** 1 MAIN ST CAMBRIDGE, MA 02142 (617) 494-8200 | EXCELERATOR, CUSTOMIZER | PC, VAXSTATION | $8400 FOR EXCELERATOR; $12,500 FOR CUSTOMIZER | | 705 |
| **NASTEC CORP** 24681 NORTHWESTERN HWY SOUTHFIELD, MI 48075 (313) 353-3300 | DESIGNAID | PC | $6900 | | 706 |
| **PROMOD INC** 22981 ALCALDE DR LAGUNA HILLS, CA 92653 (714) 855-3046 | PROMOD/SA PROMOD/RT PROMOD/MD PROMOD/SC | PC, VAX | FROM $500 TO $39,950 PER MODULE | PROMOD/SA,/RT,/MD, AND /SC SUPPORT STRUCTURED AND REAL-TIME ANALYSIS, MODULAR DESIGN, AND SOURCE-CODE GENERATION, RESPECTIVELY. | 707 |
| **RATIONAL** 1501 SALADO DR MOUNTAIN VIEW, CA 94043 (415) 940-4770 | RATIONAL ENVIRONMENT | RATIONAL WORKSTATION | $295,000 TO $795,000 | PRICE INCLUDES RATIONAL'S SOFTWARE AND PROPRIETARY HARDWARE. | 708 |
| **TEKTRONIX INC** DESIGN AUTOMATION GROUP BOX 4600, MAIL STOP 92-635 BEAVERTON, OR 97076 (503) 629-1573 | 2167 DOCUMENTATION SUPPORT PACKAGE | VAX MICROVAX II VAXSTATION | $2500 | PRICE QUOTED IS FOR 2167 SUPPORT ONLY; VENDOR ALSO MAKES OTHER CASE TOOLS. | 709 |

# 2 IN A SERIES

# Tektronix Delivers Integrated PCB Design Capture, Simulation, Layout and Manufacture.

**Tektronix Aided Engineering**

Choosing the right PCB design solution can be a challenge.

Especially when you consider that today's dense, multilayer designs combine digital and analog technologies with both through-hole and surface-mount packages.

The one sure way to meet your design requirements is with the PCB WorkSystem.™

Developed by Tektronix as part of Tektronix Aided Engineering, the PCB WorkSystem combines design capture, verification, documentation and PCB layout into one powerful solution.

Which means you get Designer's Database Schematic Capture, industry-standard HILO-3® logic simulation and MERLYN-P™ layout. All in the same PCB design environment.

So you can capture your schematic, simulate the circuit, fully place and route your design, and then transfer CAM output data to manufacturing.

The PCB WorkSystem also lets you manage Engineering Change Order iterations more efficiently. The system's automatic forward and backward annotation tools ensure that your schematic always matches your layout.

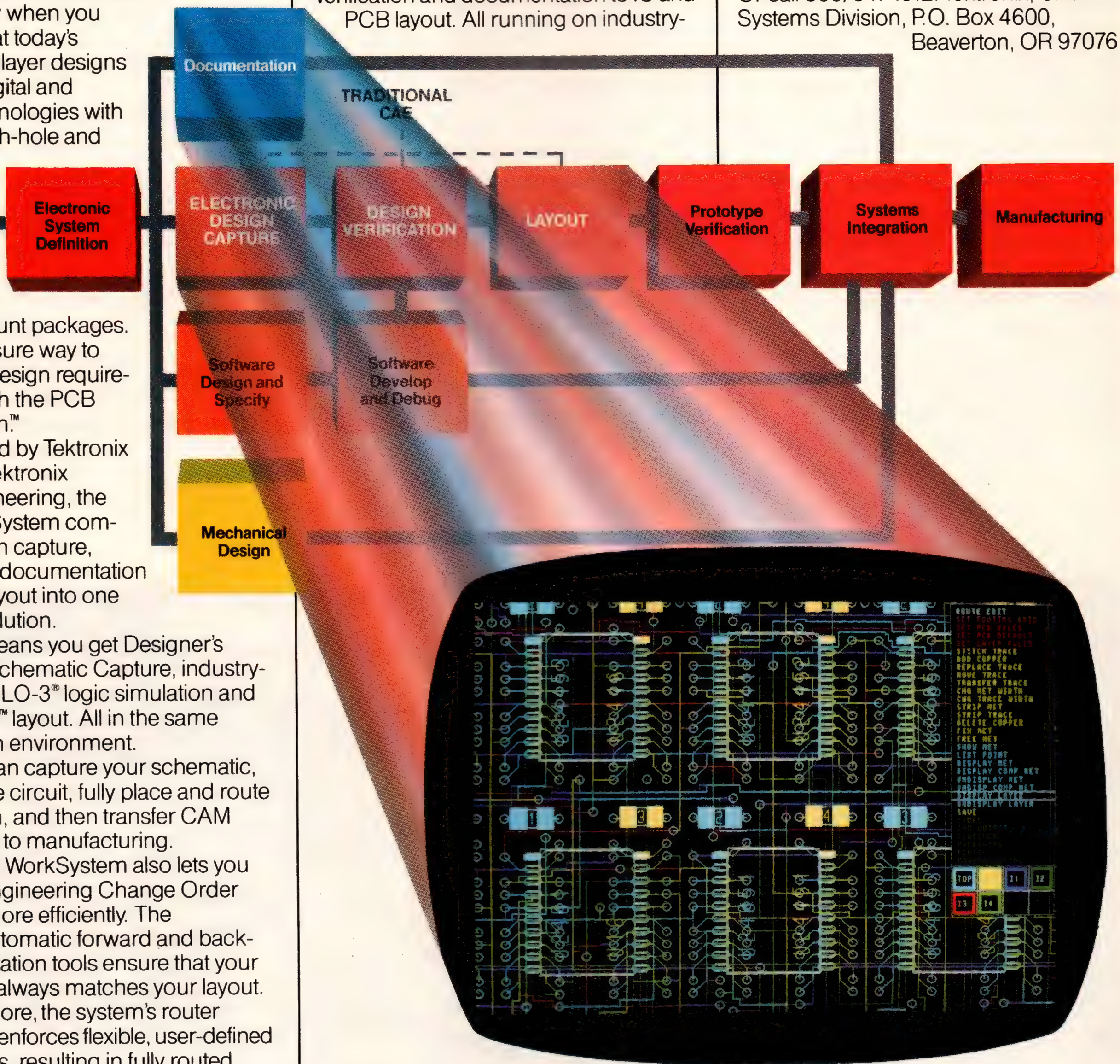
What's more, the system's router completely enforces flexible, user-defined design rules, resulting in fully routed designs that meet your manufacturing requirements.

When you're ready to fabricate your boards, the Tektronix PCB division provides you with automated manufacturing, on-time delivery and consistent quality control.

It's all part of Tektronix Aided Engineering. A family of integrated WorkSystems addressing each area of your electronic design cycle. From design capture, verification and documentation to IC and PCB layout. All running on industry-standard platforms from Apollo® and DEC.™

Best of all, it's from Tektronix. The name you've always trusted to get the engineering job done. So you're assured of worldwide service, support and training.

To take advantage of Tektronix Aided Engineering, contact your local Tektronix, CAE Systems Divisions, sales office, Or call 800/547-1512. Tektronix, CAE Systems Division, P.O. Box 4600, Beaverton, OR 97076.




WorkSystem, DDSC, and MERLYN-P are trademarks of Tektronix, Inc. HILO is a registered trademark of GenRad, Inc. Apollo is a registered trademark of Apollo Computer, Inc. DEC is a trademark of Digital Equipment Corp.

**Tektronix®**
COMMITTED TO EXCELLENCE

CIRCLE NO 104

gy also permits customization of the basic package. Rather than requiring the programming and linking of the subroutines to the main program as Teamwork's Access does, Excelerator's Customizer has a menu-driven interface, allowing you to customize the basic program with little programming effort. You can also insert the customized features into the main menus for easy operator access.

You can run all of the CASE programs covered in this article on either the IBM PC or a VAX machine; some also run on the Sun or Apollo workstations (see **Table 1**). PC-based systems offer ready hardware availability and lower costs for the software. A PC-based system may be right for you if you want to explore structured analysis and design as well as its documentation capabilities. The first package you buy may not necessarily be what your company standardizes on in two years.

Tom Scott, director of marketing for Promod, says that Promod now prices its PC-based software in building-block units because engineers want to be able to pick and choose their options; engineers have very focused areas they want to explore.

**File-linking capability**

George Tice, technical support specialist at Tektronix, suggests that an advantage of using a VAX-based package is that such a package can operate under the VMS operating system, which offers powerful file-handling and networking capabilities. These capabilities are useful if you need to link to files not in the CASE system, such as hardware CAD files. Networking is particulary useful in projects with many engineers (a typical situation for the development of a program with a million lines of code) who need to access the same files.

With the Exception of the Rational system, none of the CASE packages specifically support 2167 documentation. This lack of specific support is unusual, because about 50% of CASE applications are military. Tektronix is introducing this month its 2167 Documentation Support Package (about $2500), which the company hopes will fill this gap.

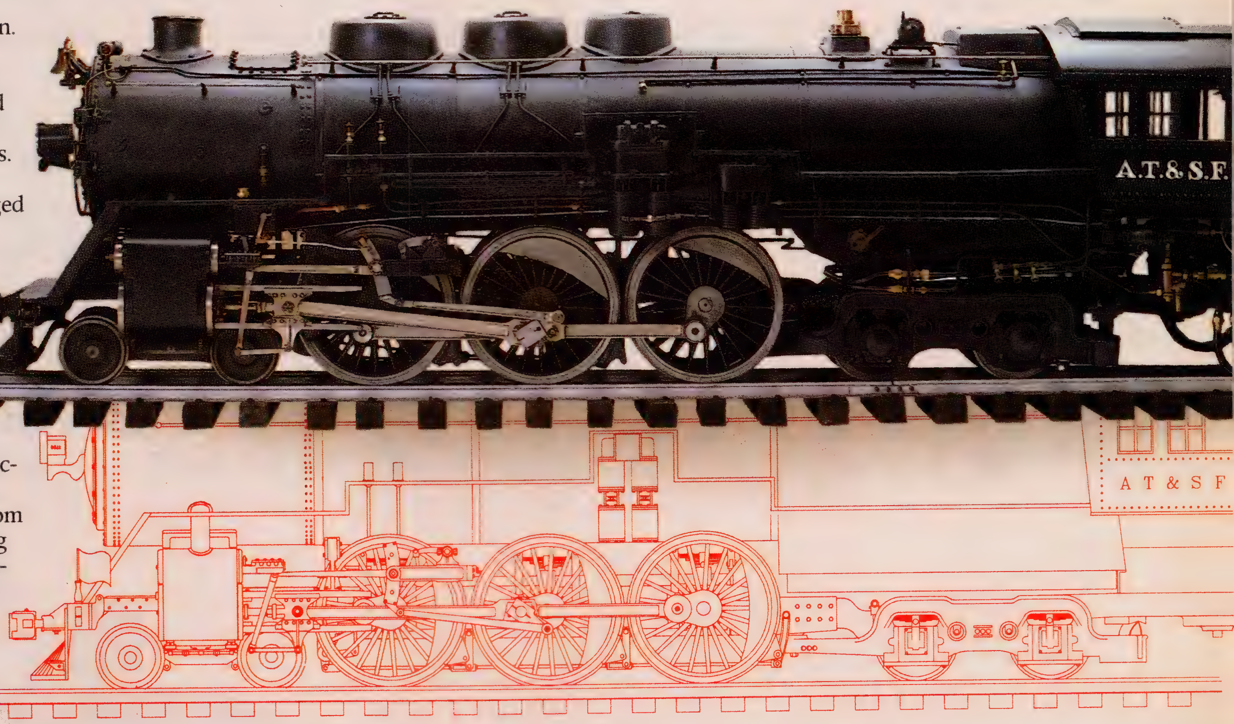
**EDN**

## References


1. Terry, Chris, "CASE tools run on an expanded range of computer systems," *EDN*, July 23, 1987, pg 220.
2. Bell, Rodney, "Structured analysis aids in μC system design," *EDN*, March 21, 1985, pg 251.


Article Interest Quotient
(Circle One)
High 515 Medium 516 Low 517

# Get on board with AutoCAD® 2.6.




Computer-aided design.
Until recently, it conjured up images of massive, room-sized computers and engineers in white lab coats.

But a few years ago, AutoCAD® changed all that. With a software package that turned the personal computer on your desk into an easy-to-use electronic drawing board.

For everything from PC boards to shopping centers. Tooling to topographical plans. Technical illustrations. Facilities layouts.

Even #4-6-4 Hudson model railroad trains.

Now AutoCAD is even better.

**Introducing AutoCAD 2.6**

Of course, the newest version of AutoCAD still has all the features that made the original the industry standard. Accuracy, Power, and Versatility.

But now, there are improvements all down the line.

Like AutoCAD 3D Level 2 which allows you to generate lines and faces at any angle on a drawing, not just on or parallel to the X-Y plane.

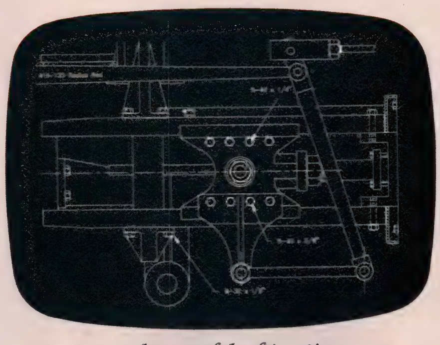
Or associative dimensioning which automatically updates dimensions after you've stretched, scaled, or rotated an object.

And transparent PAN, VIEW, and ZOOM, which you can use while another command is in progress.

The result? A powerful electronic drawing tool that lets you concentrate on the drawing, and not on the electronics.

**Feel Comfortable at the Controls**

Never used a computer before? AutoCAD's easy-to-use menus guide you from action to action. You can even create your own menus. And use an on-line "HELP" command if you get stuck.



*Save hours of drafting time. Draw frequently used diagrams just once and re-enter where needed.*

What if you have second thoughts, or make a mistake? AutoCAD's new, sweeping UNDO capability lets you erase what you've done—so you have total freedom to draw and experiment.

There are also enhanced customization features. Support for over 30 different microcomputers (as well as several 32-bit UNIX-based systems). Even support for the new IGES standard, to let you easily and accurately translate drawings between AutoCAD and most other CAD systems.

All of which combine to make the new AutoCAD fit more neatly and comfortably than ever into the way you're used to working.

**How to Get on Board**

For a demonstration of AutoCAD 2.6, or any of our other products, call or write us for the name of the dealer nearest you.

Call us too if you want the location and telephone number of your nearest Authorized AutoCAD Training Center.

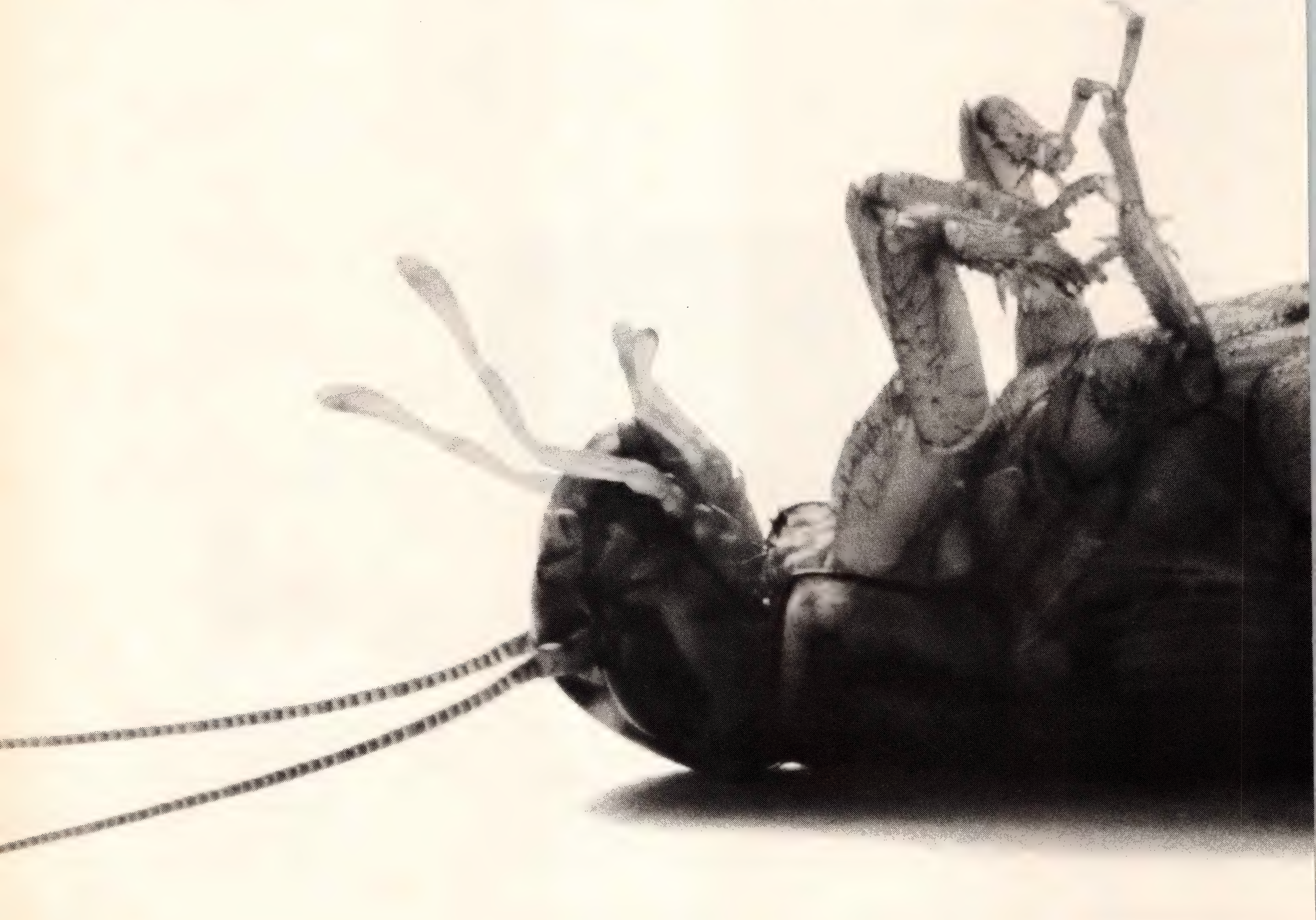
We'll make sure you get headed down the right track.

AUTOCAD®

AUTODESK, INC.
2320 MARINSHIP WAY
SAUSALITO, CA 94965
(800) 445-5415
TELEX 275946 ACAD UD
COMPUSERVE GO ADESK

Drawing Courtesy of Little Engines, Inc.

CIRCLE NO 102



# evelopment system, bility is a dead issue.

including those requiring multiprocessors.

And by building your application this way, you'll save time, money, and most of all, a lot of worry. Because VRTX has been proven in everything from traffic lights to underwater robots to F-14's.

You won't get trapped in a technological corner, either.

VRTX works with every member of every major microprocessor family, which we support with Ada® and C compilers. Plus high level language libraries for other standard compilers, and a multi-processor debugger.

So why not put out a feeler? Call us at (800) 228-1249, or (214) 661-9526 from Texas. Or write Ready Systems, 449 Sherman Ave., P.O. Box 61029, Palo Alto, CA 94306-9991.

And start your next software development project with a leg up.

READY SYSTEMS

Real Time for the Real World.



CIRCLE NO 101

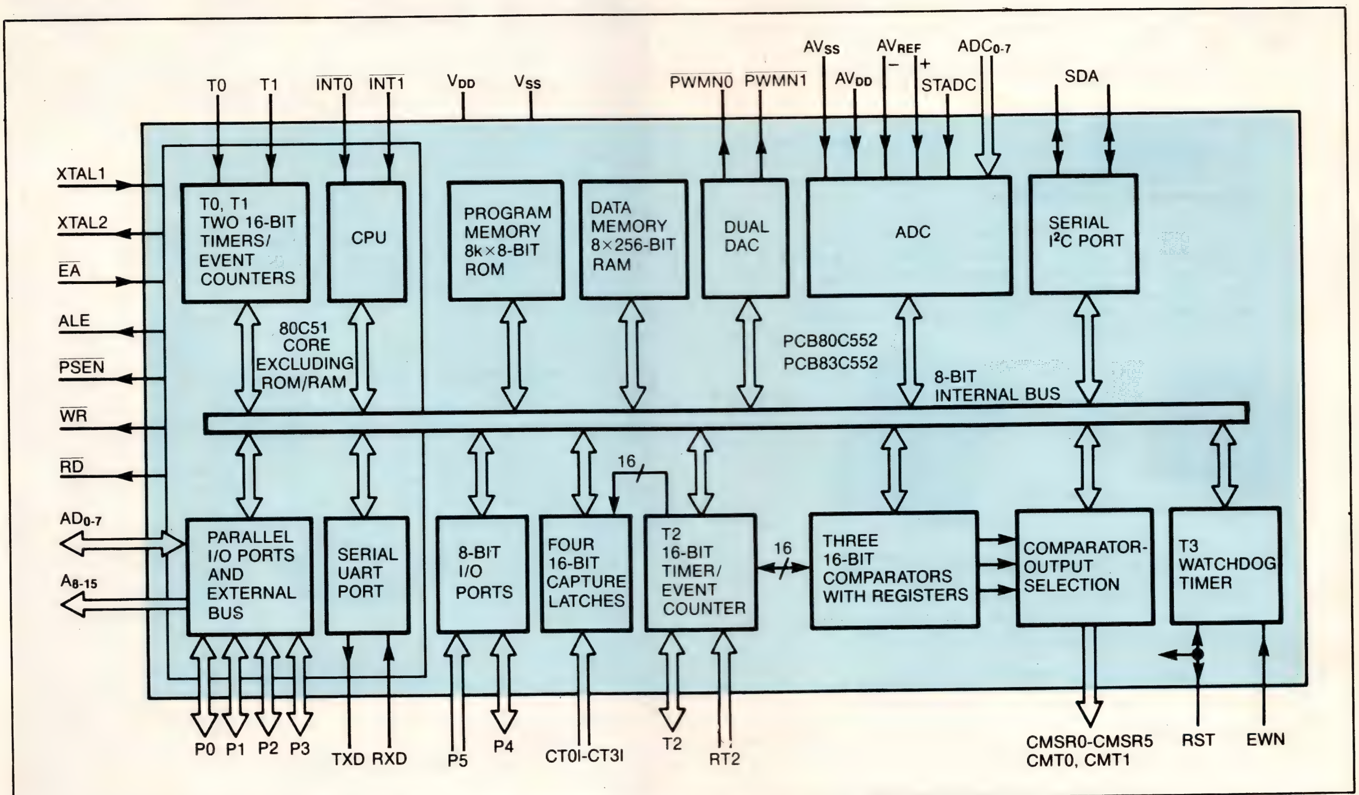
# Single-chip microcontroller offers analog and digital I/O facilities

Although the PCB83C552 single-chip CMOS microcontroller targets automotive-engine and -gearbox management systems, its numerous analog and digital I/O facilities make it suitable for use in a wide variety of applications, such as medical, instrumentation, and industrial-control equipment. The microcontroller is based on the 80C51 architecture and instruction set. Its functional enhancements include an 8-channel, 10-bit A/D converter; two pulse-width-modulated (PWM) outputs; additional parallel I/O ports; an additional timer/counter; and an I²C-bus interface.

***By including an A/D converter and two PWM outputs on chip,*** *the PCB83C552 eliminates a significant amount of the external circuitry that many applications would otherwise require.*

The microcontroller has six 8-bit parallel I/O ports, of which ports P0, P2, and P3 are identical in function to those of the same names on the 80C51. Port P1 can also operate in the same fashion that the 80C51's port P1 does. On the PCB83C552, however, P1's I/O lines have alternative functions that provide control inputs for the chip's additional counter/timer and that provide serial clock and data lines for the 2-line I²C-bus interface.

The quasi-bidirectional, parallel I/O capabilities of the PCB83C552's port P4 are similar to those of ports P1, P2, and P3. However, you can also couple P4 to one of the on-chip timer/counters so that when the timer/counter reaches predetermined points, six of P4's outputs are set or reset, and two of its outputs are toggled. Port P5 operates only




***Besides including the facilities you'd expect to find in an 80C51,*** *the PCB83C552 provides an 8-channel, 10-bit A/D converter; two PWM outputs; additional parallel I/O ports and timers; and an I²C-bus interface.*

as an input port, but you can use it either as an 8-bit digital input port or as an 8-channel analog input port for the A/D converter's input multiplexer.

The two PWM outputs have dedicated output pins. An 8-bit control register allows you to select a common repetition frequency (in the range from 92 Hz to 23.5 kHz for a 12-MHz clock frequency) for both outputs. Two more registers allow you to define the mark/space ratio for each individual channel in the range from 0 to 1, with 8-bit resolution. The PWM outputs are driven by push-pull drivers; therefore, with only simple external filtering, you can derive two analog outputs (with 8-bit resolution) from the PWM outputs.

The analog input circuitry comprises an 8-channel analog input multiplexer and an A/D converter with 10-bit resolution. The A/D-conversion time is 50 machine cycles (50 μsec with a 12-MHz clock frequency). An 8-bit control/status register allows you to select a particular input channel, to software-trigger the A/D converter or enable or disable an external trigger, and to interrogate the A/D converter's busy flag and end-of-conversion interrupt flag.

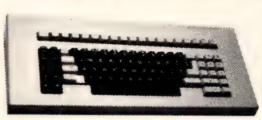
Besides providing the two 16-bit timer/event counters found in an 80C51, the PCB83C552 has an additional 16-bit, readable timer/counter with associated capture and compare registers. This timer/counter is clocked by a programmable divide-by-1, -2, -4, or -8 prescaler, which itself is either clocked internally at 1/12 of the chip's clock frequency or clocked from an external input. The four 16-bit capture registers allow external, edge-triggered inputs to capture the contents of the timer/counter and simultaneously generate an interrupt.

In addition, three programmable comparators continuously monitor this timer/counter and generate interrupts when their contents and the contents of the timer/counter match. You can also arrange for these comparators to set, reset, or toggle selected bits on port P4's output pins, and you can generate interrupts on 8- and 16-bit overflows from the timer/counter.

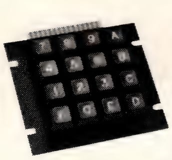
Besides including the full-duplex UART you'd expect to find in an 80C51, the PCB83C552 also has an I²C-bus serial interface, which you can operate as an I²C-bus master or slave. Hardware within the chip handles data transfer, clock generation, address recognition, and bus arbitration, minimizing the software overhead involved in controlling the I²C bus.

Access to the control and status registers that manage these on-chip peripherals is provided within the microcontroller's 256-byte RAM space. These registers overlap the

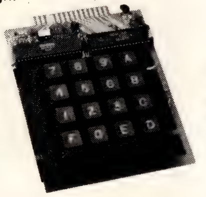






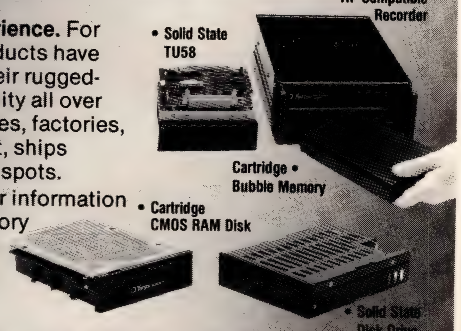






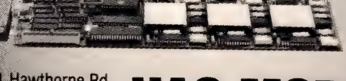












PHILIPS

# Performance Drive

TEST & MEASUREMENT - SYNTHESIZER/FUNCTION GENERATORS


Our new series of three high performance programmable sythesizer/function generators puts just the performance you need right to hand.

Each model features **8-digit frequency resolution,** so setting accuracy down to 0.1 mHz is guaranteed, and **quartz crystal precision** for long-term stability and reproducibility.

They're **GPIB-bus compatible** also, so each can be used within an automated system environment, and they can be stacked in a 19" rack.

Consider the top-of-the-range **PM 5193** model, for example. A 50 MHz instrument with a full 11½ decade frequency range, it offers 8 selectable waveforms; 5 standard plus 3 ns-pulse (positive- and negative-going) and Haversine, and a choice of modulation modes – AM, FM, gating, sweep, and counted Burst.

Moreover, internal modulation can be programmed up to 200 kHz, and up to 10 complete panel settings can be stored for instant recall whenever needed . . . just set and forget!

For lower frequency applications, there is the general-purpose **PM 5192, 20 MHz** model and the economic **PM 5191, 2 MHz** model; both offering equally impressive high performance.

Product credibility too, is assured because the PM 5191/92/93 series is backed by the corporate resources of one of the world's largest electronics companies.

## *Advanced technology made to measure*

Write to: Philips I&E, T&M department, Building HKF 70, 5600 MD Eindhoven, The Netherlands or call your local supplier: **Austria** (222) 62 9141; **Belgium** (2) 525 66 92/94; **Denmark** (1)57 22 22; **Finland** (0) 525 72 25; **France** (1) 49 42 80 00; **Germany** (561) 50 10; **Great Britain** (0223) 35 88 66; **Ireland** (1) 69 33 55; **Italy** (39) 36 35 240/8/9; **Netherlands** (40) 78 28 08; **Norway** (2) 68 02 00; **Portugal** (1) 68 3121; **Spain** (1) 404 22 00; **Sweden** (8) 782 18 00; **Switzerland** (1) 488 22 11

top 128 bytes of the RAM space; you access the registers by directly addressing this area of RAM, and you access the overlapped 128 bytes of data RAM by indirect-addressing operations.

A 2-level interrupt handler manages interrupts generated by the 13 on-chip and two external interrupt sources. Interrupt-mask and interrupt-control registers allow you to enable and disable individual interrupt sources and assign them to either of the two interrupt levels. You can globally enable and disable interrupt sources, and you can program the external interrupt sources to be level- or edge-sensitive.

In the event of program or system crashes, an 8-bit watchdog timer with an 11-bit prescaler allows you to generate processor resets at periods of between 2 msec and 0.5 sec for a clock frequency of 12 MHz.

The PCB83C552, which includes 8k bytes of mask-programmable ROM, is also available in a ROM-less version, the PCB80C552. Both versions let you expand ROM and RAM externally to as much as 64k bytes. The devices consume 125 mW typ, and they have idle and power-down modes that reduce their 5V power-supply current to 10 mA and 50 μA, respectively. Both devices come in 68-pin plastic leaded chip carriers and operate over 0 to 70°C. A version that operates over −40 to +110°C is under development. Samples are available now; production quantities will be available in the fourth quarter of 1987 and will sell for around DM 26 (10,000).

**—Peter Harold**

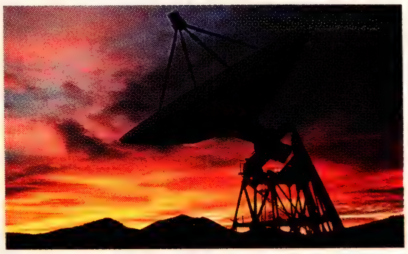
*Philips, Elcoma Div, Box 523, 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.*

**Circle No 630**

*Signetics Corp, 811 E Arques Ave, Sunnyvale, CA 94088. Phone (408) 991-4571.*

**Circle No 631**

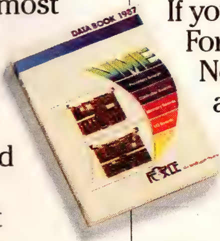
# In the grand design of VME, where do we fit in?



performance that lasts. Because our standards are based on NATO guidelines. And our Q/A policies are merciless. Every board is 100% in-circuit tested. Then 100% functional tested. And, as if that's not enough, they're put through 100% dynamic burn-in. No wonder our return rate is less than 0.9%. And dropping fast.

***Support you can count on.***

As you might expect, our support is as uncompromising as our quality. Take our documentation. It's the most thorough and detailed in the business. Applications support? No one else delivers it faster or better. Just need a question answered? Call Force and you'll get somebody who's really qualified to help.




***You can always get what you want.***

Fed up with the 30-day promise and 90-day wait? Get your boards from Force and you'll have them in your racks in 30 days. Period. Nobody gives you better on-time delivery. Period.

***We'll throw the book at you.***

If you've got a VME problem, Force has the solution. Nobody offers more. Give us a chance to prove it. Call today and we'll send you our free 380-page data book. You'll find that for your application, we'll fit in quite well.

Call toll-free: 1-800-BEST VME. In California, 1-800-237-8862.


FORCE COMPUTERS®

FORCE COMPUTERS, INC.
727 University Ave. Los Gatos, CA 95030
Phone (408) 354-3410
Telex 172465 Telefax (408) 395-7718

FORCE COMPUTERS, GmbH
Daimlerstrasse 9 D-8012 Ottobrunn
Telefon (089) 60091-0 Telex 524190 forc-d
Telefax (089) 6 097793

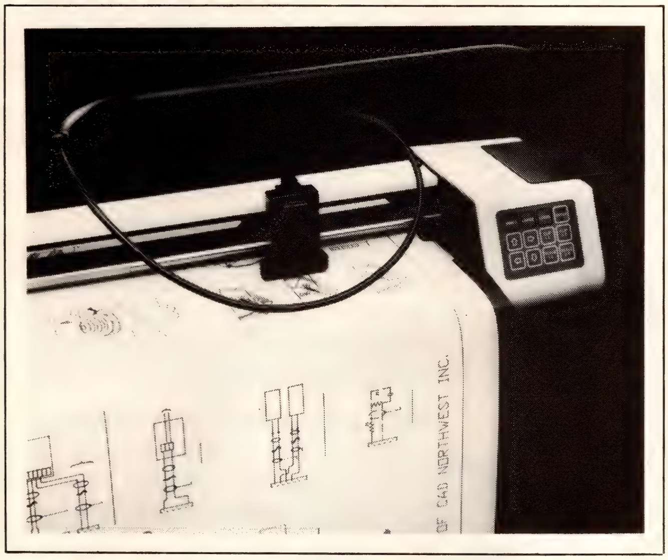




CIRCLE NO 98

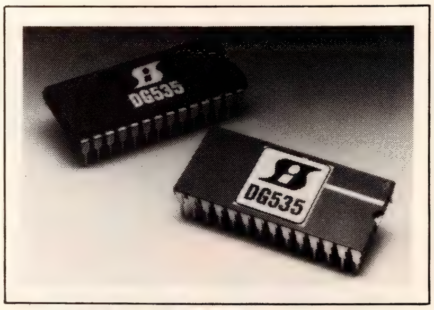
# READERS' CHOICE

Of all the new products covered in EDN's **June 11, 1987**, issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, find out what makes them special: Just circle the appropriate numbers on the Information Retrieval Service card, or refer to the indicated pages in our **June 11, 1987**, issue.



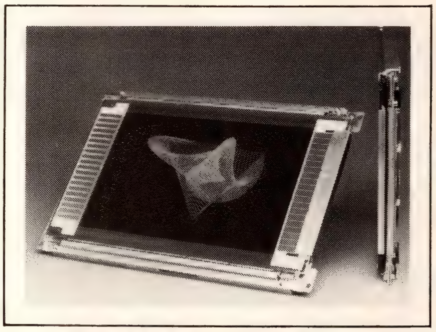

### ▲ DRAWING SCANNER

The Scan-Cad is a 200-dot/in. scanning head that you can add as an option to the company's DMP-50 Series pen plotters (pg 251).
**Houston Instrument.**
**Circle No 602**



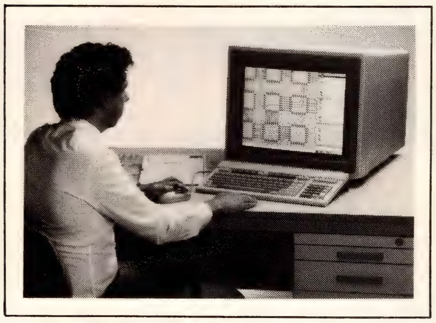

### ▲ VIDEO MUX

The DG535 is a wideband, 16-channel monolithic video multiplexer that features CMOS logic and single-supply operation with 75-μW power dissipation (pg 240).
**Siliconix Inc.**
**Circle No 601**



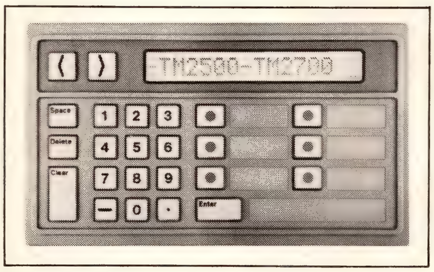
### ▲ PLASMA DISPLAY

The FPF-8050-HFUG plasma display features 64-bit LSI drivers and requires only 35W at full illumination (pg 223).
**Fujitsu Component of America Inc.**
**Circle No 603**



### ▲ CAE SYSTEM

The IDS40000 CAE workstation, based on the Hewlett-Packard 9000 Series 300 Unix computer, incorporates software modules that perform schematic capture, logic simulation, pc-board layout, and mechanical design (pg 256).
**Wayne Kerr Datum Ltd.**
**Circle No 604**
**Wayne Kerr Inc.**
**Circle No 605**




### ◀ TERMINALS

The TM2500 and TM2700 terminals are designed for operator-interface and data-collection applications (pg 235).
**Burr-Brown Corp.**
**Circle No 606**


INMOS and IMS are trademarks of the INMOS Group of Companies.

You've seen the advantages offered by the A100 Digital Signal Processor. The single-chip DSP solution that features 32 multiply-accumulators, executes up to 320 MOPs, and easily attaches to microprocessors.

Now INMOS speeds A100 system development with the new D704, the complete DSP Development System. The D704 overcomes the clutter normally encountered in developing DSP systems such as hand-crafted assemblers, interleaved busses and power-hungry glue. And since it is tailored for the A100, your end product is first to market and second-to-none in performance.

The D704 combines a comprehensive set of software tools, PC plug-in card and extensive documentation, providing a powerful yet easy-to-use DSP environment. You can experiment with the technology, simulate DSP algorithms in software and run them in real time on the A100's provided on the board.

The A100 is quickly becoming the number one choice in everything from avionics to ultrasonics. And with MIL-STD 883C devices available soon, it will be a natural for military DSP programs of all types. With the D704 Development System, creating DSP solutions has never been easier.

So if you'd like to cut through the clutter, start by clipping the coupon.

**THE A100 DSP FAMILY**

| | |
|---|---|
| **IMS A100** | Single-Chip 32-Stage Cascadable Transversal Filter—16-Bit Data, 16-Bit Coefficients, 320 MOPs |
| **IMS B009** | PC Plug-In Card Including Four A100's |
| **IMS D704** | IMS B009 + Interactive Software Simulator/ DSP Development Suite |

inmos®

I'd like to cut through the clutter. Please send me full details of the IMS D704 DSP development system.

Name ________ Title ________

Company ________

Address ________

Telephone ________

INMOS Corporation, PO Box 16000, Colorado Springs, Colorado 80935. Tel (303) 630-4000.

INMOS Limited, PO Box 424, Bristol BS99 7DD. Tel (0454) 616616.

CIRCLE NO 97

# LEADTIME INDEX

Percentage of respondents

| ITEM | Off the shelf | 1-5 weeks | 6-10 weeks | 11-20 weeks | 21-30 weeks | Over 30 weeks | Average (weeks) | Last month's average (weeks) |
|---|---|---|---|---|---|---|---|---|
| **TRANSFORMERS** | | | | | | | | |
| Toroidal | 0 | 29 | 57 | 14 | 0 | 0 | 7.6 | 9.5 |
| Pot-Core | 0 | 50 | 33 | 17 | 0 | 0 | 6.8 | 8.8 |
| Laminate (power) | 0 | 25 | 33 | 34 | 8 | 0 | 10.7 | 7.1 |
| **CONNECTORS** | | | | | | | | |
| Military panel | 0 | 20 | 40 | 0 | 0 | 40 | 16.2 | 10.7 |
| Flat/Cable | 25 | 38 | 37 | 0 | 0 | 0 | 4.1 | 5.7 |
| Multipin circular | 11 | 34 | 22 | 22 | 0 | 11 | 9.7 | 10.3 |
| PC | 11 | 34 | 22 | 22 | 0 | 11 | 9.7 | 5.8 |
| RF/Coaxial | 11 | 34 | 33 | 22 | 0 | 0 | 7.1 | 9.0 |
| Socket | 8 | 42 | 33 | 17 | 0 | 0 | 6.5 | 5.7 |
| Terminal blocks | 8 | 54 | 31 | 7 | 0 | 0 | 5.3 | 4.6 |
| Edge card | 11 | 33 | 45 | 11 | 0 | 0 | 6.3 | 6.6 |
| Subminiature | 0 | 42 | 33 | 17 | 8 | 0 | 8.6 | 8.2 |
| Rack & panel | 0 | 50 | 33 | 17 | 0 | 0 | 6.8 | 7.7 |
| Power | 0 | 33 | 34 | 33 | 0 | 0 | 8.8 | 8.4 |
| **PRINTED CIRCUIT BOARDS** | | | | | | | | |
| Single-sided | 7 | 22 | 57 | 7 | 0 | 7 | 8.5 | 5.1 |
| Double-sided | 0 | 47 | 47 | 6 | 0 | 0 | 6.2 | 6.7 |
| Multilayer | 0 | 15 | 54 | 31 | 0 | 0 | 9.5 | 8.7 |
| Prototype | 0 | 83 | 17 | 0 | 0 | 0 | 3.8 | 3.8 |
| **RESISTORS** | | | | | | | | |
| Carbon film | 31 | 25 | 38 | 6 | 0 | 0 | 4.7 | 3.6 |
| Carbon composition | 36 | 27 | 37 | 0 | 0 | 0 | 3.7 | 4.9 |
| Metal film | 20 | 33 | 47 | 0 | 0 | 0 | 4.7 | 4.3 |
| Metal oxide | 8 | 42 | 42 | 8 | 0 | 0 | 5.9 | 3.7 |
| Wirewound | 8 | 38 | 46 | 8 | 0 | 0 | 6.0 | 5.6 |
| Potentiometers | 6 | 38 | 50 | 6 | 0 | 0 | 6.1 | 7.4 |
| Networks | 20 | 20 | 40 | 20 | 0 | 0 | 6.9 | 5.7 |
| **FUSES** | 18 | 36 | 46 | 0 | 0 | 0 | 4.7 | 3.6 |
| **SWITCHES** | | | | | | | | |
| Pushbutton | 33 | 11 | 45 | 11 | 0 | 0 | 5.6 | 4.9 |
| Rotary | 18 | 27 | 37 | 18 | 0 | 0 | 6.5 | 7.7 |
| Rocker | 9 | 46 | 27 | 18 | 0 | 0 | 6.4 | 6.5 |
| Thumbwheel | 20 | 20 | 30 | 30 | 0 | 0 | 7.7 | 7.2 |
| Snap action | 9 | 46 | 27 | 18 | 0 | 0 | 6.4 | 5.6 |
| Momentary | 10 | 40 | 30 | 20 | 0 | 0 | 6.7 | 5.1 |
| Dual in-line | 0 | 40 | 40 | 20 | 0 | 0 | 7.5 | 6.6 |
| **WIRE AND CABLE** | | | | | | | | |
| Coaxial | 30 | 40 | 30 | 0 | 0 | 0 | 3.6 | 4.4 |
| Flat ribbon | 23 | 39 | 38 | 0 | 0 | 0 | 4.2 | 5.2 |
| Multiconductor | 9 | 46 | 45 | 0 | 0 | 0 | 5.0 | 5.8 |
| Hookup | 27 | 53 | 20 | 0 | 0 | 0 | 3.2 | 3.0 |
| Wire wrap | 18 | 46 | 36 | 0 | 0 | 0 | 4.3 | 3.8 |
| Power cords | 21 | 29 | 36 | 14 | 0 | 0 | 5.9 | 5.1 |
| **POWER SUPPLIES** | | | | | | | | |
| Switching | 9 | 27 | 37 | 27 | 0 | 0 | 8.0 | 8.6 |
| Linear | 0 | 25 | 50 | 25 | 0 | 0 | 8.6 | 6.9 |
| **CIRCUIT BREAKERS** | 10 | 40 | 40 | 10 | 0 | 0 | 6.0 | 6.1 |
| **HEAT SINKS** | 17 | 58 | 17 | 8 | 0 | 0 | 4.4 | 5.8 |
| **RELAYS** | | | | | | | | |
| General purpose | 0 | 54 | 23 | 23 | 0 | 0 | 7.0 | 6.8 |
| PC board | 0 | 33 | 9 | 58 | 0 | 0 | 10.7 | 8.6 |
| **RELAYS** | | | | | | | | |
| Dry reed | 0 | 38 | 25 | 37 | 0 | 0 | 8.9 | 8.5 |
| Mercury | 0 | 33 | 34 | 33 | 0 | 0 | 8.8 | 9.8 |
| Solid state | 11 | 33 | 22 | 34 | 0 | 0 | 7.9 | 10.1 |
| **DISCRETE SEMICONDUCTORS** | | | | | | | | |
| Diode | 22 | 22 | 28 | 28 | 0 | 0 | 7.2 | 5.3 |
| Zener | 20 | 20 | 33 | 27 | 0 | 0 | 7.4 | 5.5 |
| Thyristor | 0 | 27 | 46 | 27 | 0 | 0 | 8.7 | 8.0 |
| Small signal transistor | 7 | 27 | 40 | 26 | 0 | 0 | 8.1 | 6.3 |
| MOSFET | 0 | 36 | 27 | 37 | 0 | 0 | 8.9 | 7.8 |
| Power, bipolar | 0 | 30 | 20 | 50 | 0 | 0 | 10.3 | 7.8 |
| **INTEGRATED CIRCUITS, DIGITAL** | | | | | | | | |
| Advanced CMOS | 0 | 31 | 31 | 38 | 0 | 0 | 9.3 | 6.5 |
| CMOS | 6 | 24 | 23 | 47 | 0 | 0 | 9.9 | 6.5 |
| TTL | 0 | 25 | 44 | 31 | 0 | 0 | 9.1 | 6.3 |
| LS | 0 | 29 | 41 | 30 | 0 | 0 | 8.7 | 6.1 |
| **INTEGRATED CIRCUITS, LINEAR** | | | | | | | | |
| Communication/Circuit | 0 | 38 | 37 | 25 | 0 | 0 | 8.0 | 7.0 |
| OP amplifier | 0 | 36 | 29 | 35 | 0 | 0 | 8.9 | 7.7 |
| Voltage regulator | 0 | 38 | 31 | 31 | 0 | 0 | 8.4 | 5.9 |
| **MEMORY CIRCUITS** | | | | | | | | |
| RAM 16k | 11 | 0 | 33 | 56 | 0 | 0 | 11.3 | 7.5 |
| RAM 64k | 11 | 0 | 33 | 56 | 0 | 0 | 11.3 | 7.9 |
| RAM 256k | 11 | 11 | 11 | 67 | 0 | 0 | 11.6 | — |
| RAM 1M-bit | 0 | 14 | 14 | 72 | 0 | 0 | 12.6 | 7.0 |
| ROM/PROM | 0 | 0 | 29 | 71 | 0 | 0 | 13.4 | 8.3 |
| EPROM 64k | 18 | 0 | 9 | 73 | 0 | 0 | 12.0 | 8.6 |
| EPROM 256k | 11 | 0 | 22 | 67 | 0 | 0 | 12.1 | — |
| EPROM 1M-bit | 0 | 17 | 0 | 66 | 17 | 0 | 15.1 | — |
| EEPROM 16k | 0 | 14 | 14 | 72 | 0 | 0 | 12.6 | 7.3 |
| EEPROM 64k | 0 | 17 | 0 | 83 | 0 | 0 | 13.4 | — |
| **DISPLAYS** | | | | | | | | |
| Panel meters | 0 | 20 | 60 | 20 | 0 | 0 | 8.5 | 8.2 |
| Fluorescent | 0 | 25 | 25 | 50 | 0 | 0 | 10.5 | 9.1 |
| Incandescent | 0 | 50 | 33 | 17 | 0 | 0 | 6.8 | 7.9 |
| LED | 17 | 25 | 33 | 25 | 0 | 0 | 7.3 | 7.4 |
| Liquid crystal | 0 | 33 | 34 | 33 | 0 | 0 | 8.8 | 9.1 |
| **MICROPROCESSOR ICs** | | | | | | | | |
| 8-bit | 9 | 18 | 46 | 27 | 0 | 0 | 8.4 | 9.0 |
| 16-bit | 14 | 0 | 29 | 57 | 0 | 0 | 11.1 | 6.8 |
| 32-bit | 29 | 0 | 28 | 29 | 14 | 0 | 10.4 | — |
| **FUNCTION PACKAGES** | | | | | | | | |
| Amplifier | 14 | 29 | 28 | 29 | 0 | 0 | 7.6 | 7.7 |
| Converter, analog to digital | 11 | 33 | 11 | 45 | 0 | 0 | 8.8 | 10.9 |
| Converter, digital to analog | 13 | 25 | 12 | 50 | 0 | 0 | 9.5 | 9.5 |
| **LINE FILTERS** | 0 | 33 | 0 | 67 | 0 | 0 | 11.3 | 8.3 |
| **CAPACITORS** | | | | | | | | |
| Ceramic monolithic | 14 | 36 | 43 | 7 | 0 | 0 | 5.6 | 6.1 |
| Ceramic disc | 17 | 42 | 33 | 8 | 0 | 0 | 5.2 | 8.9 |
| Film | 15 | 31 | 39 | 15 | 0 | 0 | 6.4 | 6.8 |
| Aluminum Electrolytic | 7 | 36 | 29 | 28 | 0 | 0 | 7.8 | 7.8 |
| Tantalum | 0 | 50 | 25 | 25 | 0 | 0 | 7.4 | 7.1 |
| **INDUCTORS** | 0 | 38 | 37 | 25 | 0 | 0 | 8.0 | 6.4 |

Source: *Electronics Purchasing* magazine's survey of buyers


Sometimes, keeping a low profile pays off.
The survival of today's combat helicopter depends on keeping a low profile. Abbott's BC100 triple output, switching DC-DC converter helps the Lynx helicopter achieve this low profile.
The BC100's low 1.875″ profile allowed 100 watts to fit into a tight space requirement. At the same time, the Lynx helicopter was able to take advantage of the economy and reliability that come from using a standard product, the BC100.
Because the BC100 meets the requirements of MIL-STD-810C, and MIL-S-901C, the Lynx program's decision to go with Abbott's BC100 will also pay off in extra survivability. Plus the BC100 features low ripple/noise and EMI within the limits of MIL-STD-461B.
For other applications that call for small yet powerful converters, Abbott offers both 100 and 200 watt models. Each available in single and triple configurations. And all with a wide array of options available.
For more information and a copy of our 1988 Military Power Supply Product Guide, call or write today.
Abbott Transistor Laboratories, Inc. Power Supply Division, 2721 S. La Cienega Blvd., Los Angeles, CA 90034 (213) 936-8185. Eastern Office: (201) 461-4411, Southwest Office: (214) 437-0697, London Office: 0737-87-3273.
WHEN RELIABILITY IS IMPERATIVE®
abbott
MILITARY POWER SUPPLIES
CIRCLE NO 95

TEXAS INSTRUMENTS REPORTS ON

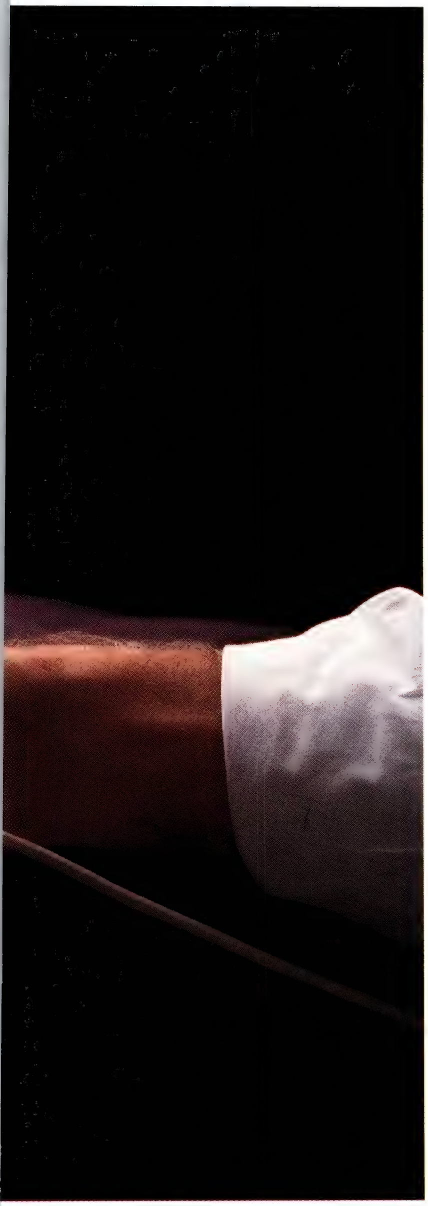
# NETWORKING

IN THE ERA OF

# MegaChip

TECHNOLOGIES

# IBM Token-Ring, Texas Instruments first.



rom Texas Instruments." All you need to apitalize on the growing demand for roducts that will operate on the ring is o design with TI's TMS380 Chip Set.

**"We use TI's TMS380 Chip Set and TI's implementation of EEE 802.2 LLC protocols to nsure IBM compatibility at nedia-access and software levels."** That is Howard S. Charney, senior vice resident of 3Com Corporation, stating the chief reason for turning to TI first when designing-in token ring connectivity. You know your TMS380-based product will be 100% compatible with IBM and industry standards.

As a result, you avoid any problems of validation, verification, or long development time. You gain time to add product enhancements that can mean a competitive edge in the marketplace.

Martin Sinnott, director, Dayton Development Center of the NCR Corporation, sums up the advantage this way: "We offer the very highest level of interoperability with the IBM Token-Ring Network via TI's TMS380 Chip Set and our own software."

## An integrated solution for "open" systems

TI's TMS380 Chip Set begins with a 40-million-bits-per-second DMA interface. This provides efficient connection to high-speed microprocessors such as Intel's 80X86 and Motorola's 680X0 families and open-system buses like IBM's Micro Channel™ and Apple's NuBus™.

Having built-in software jointly copyrighted by IBM and TI, the TMS380 provides all IEEE 802.5 media-access control processing, including on-board network-management services *(see box)*. In addition, the TMS380 provides capability for message-buffer expansion and higher layer protocols, such as IBM-compatible IEEE 802.2 Logical Link Control (LLC), available from TI.

The TMS380 completes your connection to the IBM Token-Ring with physical-layer interface circuits that provide clocking, data reception and transmission, and ring-insertion control.

Opening the way to internetworking the TMS380 facilitates the design of token ring bridge and gateway products.

## Good news about cost

Another reason to choose the TMS380 is that the cost of connectivity is coming down. The chip set is available now at a suggested resale price under $100.00 (quantity 100).

The TMS380 reflects the influence of TI's MegaChip™ Technologies. These are the skills and disciplines acquired through ongoing development of high-density circuits which generate advances in semiconductor design, processing, manufacturing, and service.

These technologies are having an effect on other LAN standards. For example, TI has developed the SN75061/62 single-channel drivers/receivers that can easily be configured for use with StarLAN IEEE 802.3 1BASE5 networks. These new devices perform data transmission/reception and minimize transmission-line noise. The SN75061 is ideally suited to 1BASE5 stations; the lower-power, lower-cost SN75062, to hubs.

**For more information** on the broad TMS380 support, turn the page.

### Reliable network management

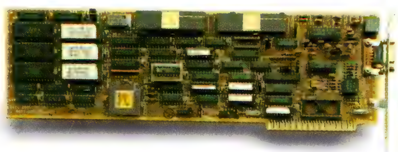
"We have designed our ProNET®-4 product using the industry-standard TI TMS380 Chip Set. In addition to normal data-communications functions, the chip set provides power-up self-test as well as network-management frames for automatic error detection, parameter services, and reconfigurations. The net effect is reliable, manageable network operation."

*Howard Salwen,*
*Chairman and Founder, Proteon, Inc.*

# Comprehensive support from TI speeds TMS380 design-in.


To help you with everything from token ring adapter-card prototyping through communications-protocol development and systems integration, TI makes available the comprehensive TMS380 Development Products Family.

**Design-in Accelerator Kit** includes hardware and debug software for completing a prototype token ring adapter: Three sample TMS380 chip sets, engi-



neering debug software with User's Guide, and an interconnect schematic.

**PC Adapter Card** helps you develop software and analyze traffic on the IBM Token-Ring Network. It works in both the PC Family and PC AT compatibles and incorporates TI's new IEEE 802.2 LLC. The card comes with demonstration software as well as protocol-analysis software to help develop your communications protocol.

**Test Wiring Concentrator (TWC)** provides the mechanism for any station to be inserted on the ring and adds LEDs that indicate ring insertion.

**TMS380 LLC EvaluationKit** provides the hardware, software, and documentation required to evaluate the IBM-compatible IEEE 802.2 LLC software on your designs.

**ASIC-LAN Tool Kit** enables the fast development of highly integrated, differentiated, and compact adapters. The kit contains ASIC software macro building blocks and completed design examples. These support Adapter Memory Expansion and PC Bus Interface. The kit not only helps save board space, but also several months of system and hardware design.

**TMS380 Bridge Design Kit** contains one TMS38021 Bridging Protocol Handler, one set of Bridge Options Adapter Software, and a TMS38021 Bridge Application Report to help you develop bridge or gateway products.

**Token Ring Seminars** are conducted on request at TI Regional Technology Centers or at your site. A two-day workshop includes an introduction to the TMS380 Chip Set and hands-on experience in the lab. A one-day TMS380 Advanced Topics Workshop provides an understanding of the extended LLC interface on the TMS380 and provides insight into bridge applications.

**For more information** on TI's TMS380 Chip Set, call TI's hot-line number, **(713) 274-2380.** Or complete and return the coupon today to Texas Instruments Incorporated, P.O. Box 809066, Dallas, Texas 75380-9066.

**Texas Instruments Incorporated** SPWO83ED70
P.O. Box 809066
Dallas, Texas 75380-9066

**YES,** please send me information on TI's networking products and services.

NAME

TITLE

COMPANY

ADDRESS

CITY STATE ZIP

AREA CODE TELEPHONE EXT.

™MegaChip and NuBus are trademarks of Texas Instruments Incorporated. Micro Channel is a trademark of International Business Machines Corporation.
®IBM is a registered trademark of International Business Machines Corporation. ProNET is a registered trademark of Proteon, Inc.

27-4512



TEXAS INSTRUMENTS

# Introducing Gould's K450B Logic Analyzer.

## 80 channels at 100 MHz for power to spare. Fast.

### Quick-shift from timing jobs to state, from easy jobs to complex ones, with ease.

At last, a logic analyzer with the power for any situation.

Only the K450B gives you up to 80 channels w/10 ns resolution, or 40 w/5 ns resolution. Even on 32-bit devices, you can analyze state *and* detailed timing without probe switching. Think of the extra time you will have and the headaches you won't.

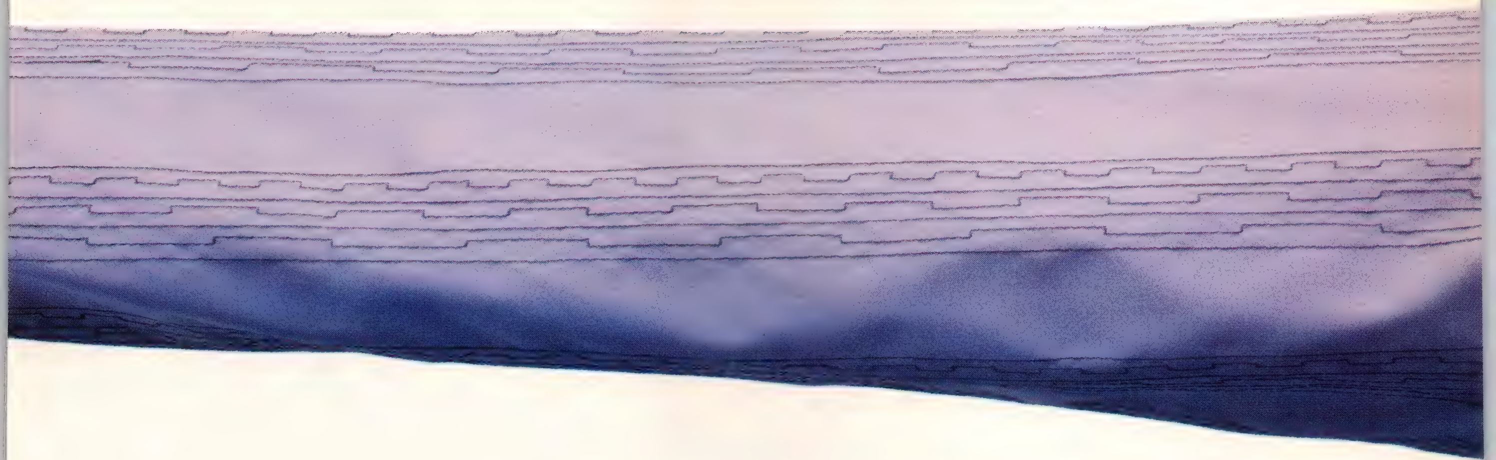
Another breakthrough is what makes all that power easy to use anytime, on any job. It's Auto Setup,™ the first automatic configuration system.

All you do is push a button. Probes are checked for activity. Threshold and appropriate clock speed are set. Channels are arranged on the screen. You get usable data in 60 seconds or less. On all channels!

**80 ch. @ 100 MHz / 40 ch. @ 200 MHz**

And don't overlook the K450B's other standard features: Ample 2K/4K memory. Auto Save for unattended triggering on preprogrammed events. Built-in disk drive. An advanced remote diagnostics function. A "Help" key when you need it. And many more. You can also order disassemblers for most popular microprocessors.

Try the K450B once, and you'll agree—not since the famous Gould Biomation K100 has a new product so elevated the performance standards for logic analyzers.



For a K450B data sheet, an application note on Trace Control™ (our unique triggering system), and the Gould Test & Measurement Systems catalog, write: Gould Inc., Test & Measurement Group, 19050 Pruneridge Ave., Cupertino, CA 95014. Or call these toll-free numbers:

U.S., Canada, Mexico:
1-800-GOULD-10

United Kingdom:
0-800-89-1095

France:
19-05-90-1345

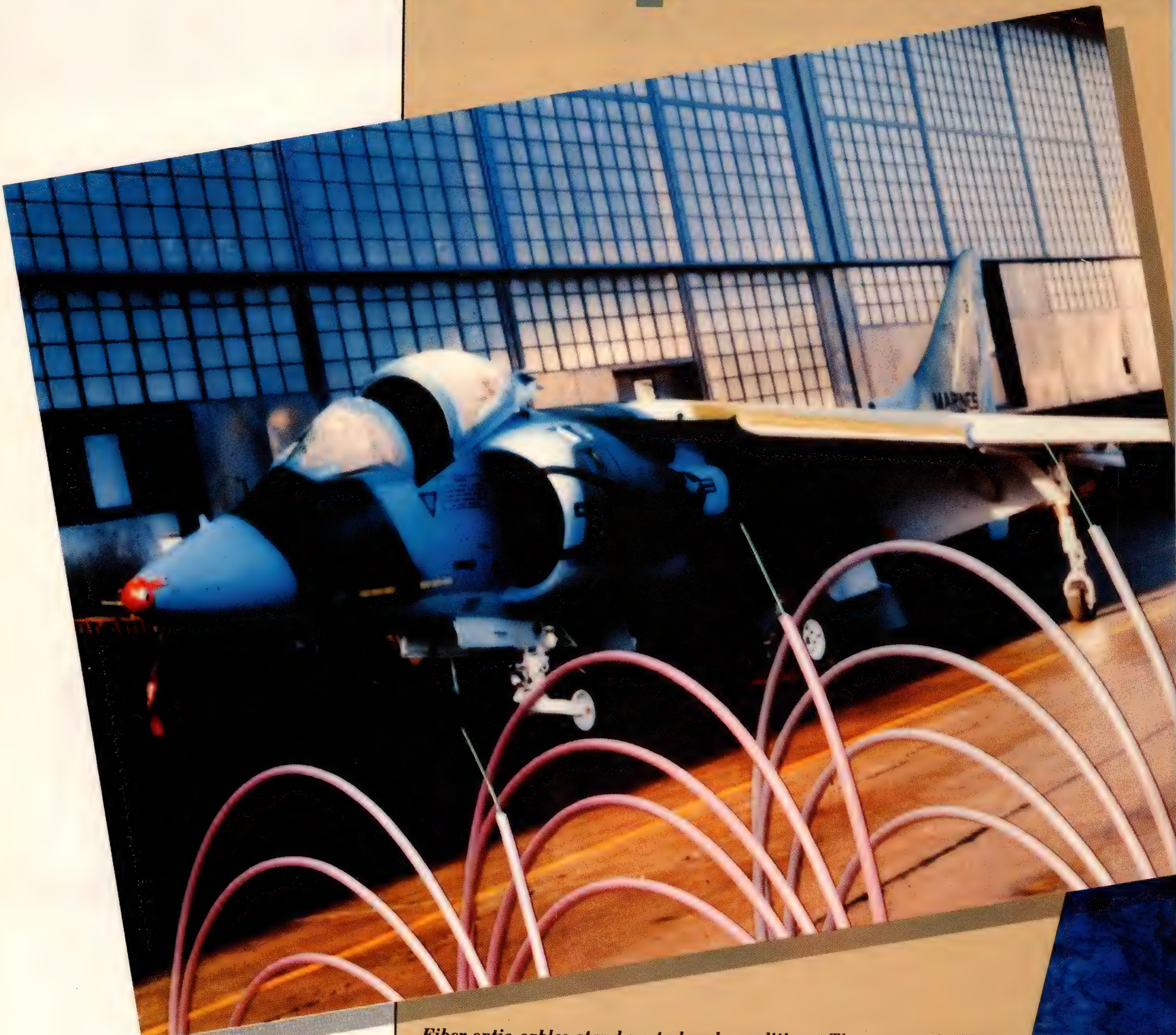
Germany:
0130-9860

GOULD
Electronics

CIRCLE NO 68

Special Report

# Military fiber-optic components



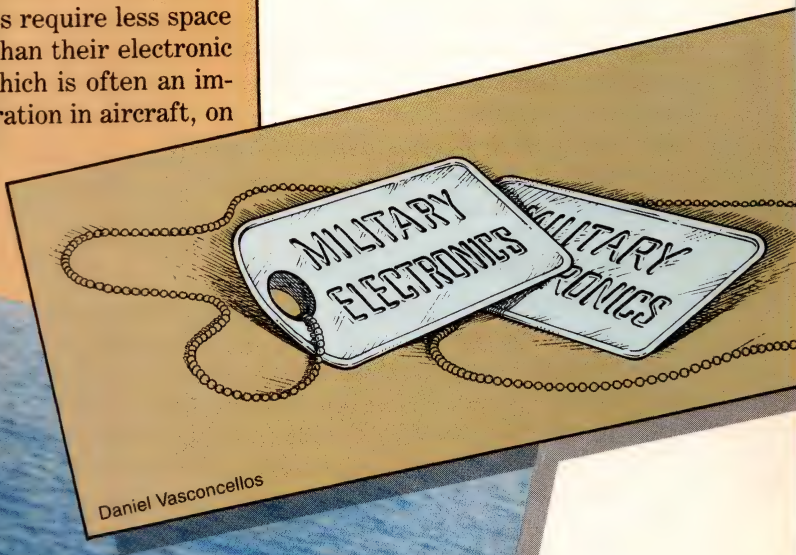

***Fiber-optic cables stand up to harsh conditions.*** *The company's Flight Light cables have a 200°C operating-range spec and are able to tolerate jet-engine compartments. Brintec's 8-fiber cables resist abrasion, compression, and mechanical forces and are part of the Navy's Aegis-class ships.*

The last decade has seen rapid growth in the field of lightwave technology. Although most of the R&D efforts have focused on telecommunications applications, where wide bandwidth and low loss are paramount considerations, interest in fiber optics for military environments is on the increase.

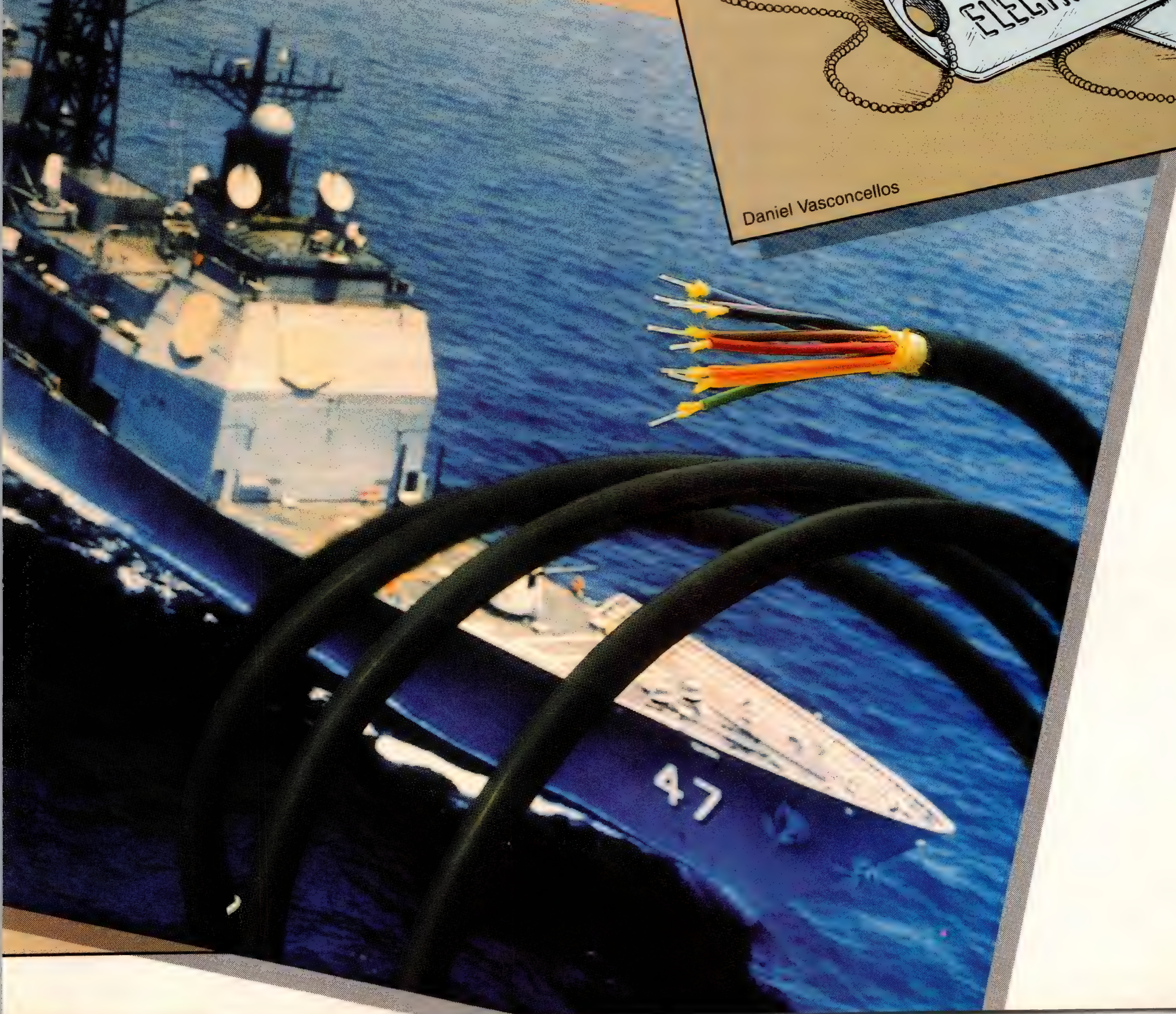
Tom Ormond, *Senior Editor*

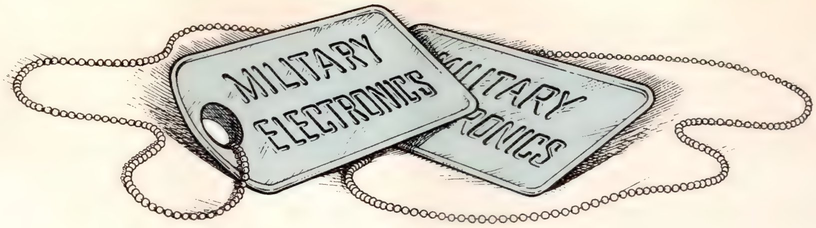
Fiber-optic components—fibers and cables, connectors, couplers, detectors, and transceivers—are finding their niche in a growing number of military applications. These applications include tactical communications systems, guided weapons, avionic data buses and control links, antisubmarine warfare nets, fixed-plant installations, sensors, and nuclear testing.

Thanks to the unique characteristics of fiber-optic components, systems based on such components offer several advantages in military environments. First of all, fiber-optic components require less space and weigh less than their electronic counterparts, which is often an important consideration in aircraft, on




Daniel Vasconcellos

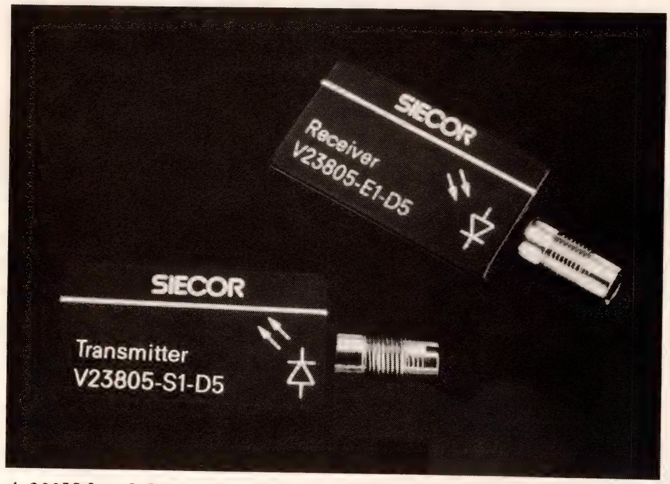





ships, and underwater. The increased information-carrying capability of fiber-optic systems can also reduce circuitry count in many applications, leading to further space and weight savings.

Second, fiber-optic technology virtually guarantees transmission security—a critical aspect of many military applications. Light signals don't emit externally detectable EMI or RFI, and fiber-optic cables are almost impossible for someone to tap without being detected.

Third, fiber-optic systems are free of interference. Because the signals are optical rather than electrical, no form of outside electrical, magnetic, or RF interference affects transmission. This is an important attribute in many tactical communication applications, as well as in nuclear testing where stray signals can influence system performance.




***A 200M-baud data rate is a key feature*** *of Siecor's transmitter and receiver modules. The modules operate at 1300 nm, employ InGaAsP source and detector elements, and are housed in hermetically sealed DIPs.*

### Addressing microwave applications

For all of these reasons, the armed services are involved in fiber-optic research to some degree, and some branches have fiber-optic-based systems already operational. The Air Force, for instance, uses a fiber-optic interface in its AN/TPS-43 tactical air defense system (Tads) because a fiber-optic interface is safe from countermeasures such as antiradiation missiles (ARMs) that home in on a radar system's electromagnetic emissions. The interface has four cables that transmit radar-related data; eight additional cables transmit voice and computer intercommunication data throughout the Tads. Because of the longer transmission distances possible with fiber optics, the command center can be over a mile from the radar itself, and there are no ground-loop problems.

The Air Force is planning to convert its AN/GPN-22 fixed-base ground-control-approach radar system to fiber optics. Military bases throughout the world use GPN-22 cables, so the cables must withstand some very harsh environmental conditions. The Air Force plans to replace all the copper coaxial cables now in place as system failures occur.

### Tethered applications are varied

Similarly, fiber optics promises to make wire-based flight-control systems obsolete. In tethered applications such as this, optical fiber provides the high data-rate capability required of sophisticated avionic systems. In addition, fiber optics offers immunity in high RFI environments (where military aircraft typically operate). The Army is currently developing the advanced digital optical control system (Adocs), which is scheduled for installation in the LHX light helicopter.

The Marine Corps has had an optical-fiber link in its AV-8B vertical/short takeoff and landing Harrier fighter since 1981. This 1-way link uses 100/140-μm fiber to transmit information such as communications control parameters, low-altitude light controls, and various low-altitude and obstacle-warning tones from the mission computer to the cockpit.

Fiber-optic technology isn't restricted to just these types of tethered applications. One prime example is the Army's fiber-optic guided missile (Fog-M). Developed by Missile Command, Fog-M detects, tracks, and eliminates targets without exposing the operator to enemy retaliation. A video camera in the missile's nose sends a video signal to the operator, who then sends commands back to the missile via the fiber-optic link. All these transmissions take place as the missile travels 287 mph.

The Navy is developing its own version of the Fog-M system, and A-7 Corsair fighter aircraft have already successfully used fiber-optic links to launch weapons while in flight. Of course, tethered system applications aren't limited to guided missiles. The Marines are using an optical-fiber link to control remotely piloted vehicles in their ground air telerobotic systems (Gaters) program.

Fiber optics is also gaining favor in naval environments. Weight is oftentimes a critical design parameter, and the absence of electrical-signal transmissions allows designers to run fiber through areas where a

*Fiber-optic technology has found its way into a number of military systems.*

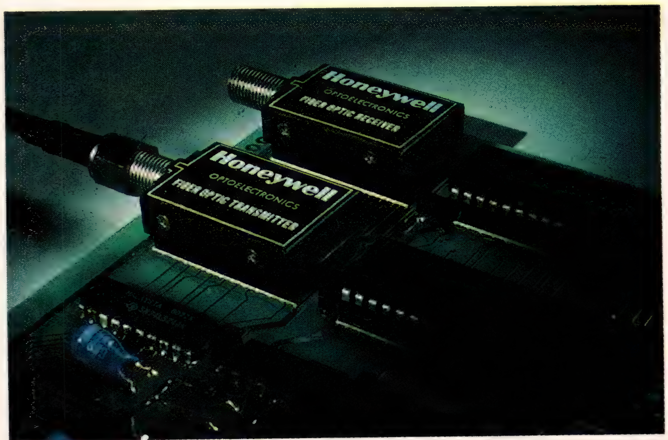
spark could be disastrous. In the Aegis program, for instance, the Navy is employing fiber optics to satisfy internal-communication requirements. Underwater surveillance is another area where the Navy is relying on fiber-optic technology extensively. In its Ariadne program, the Navy is developing warfare sensor networks made of hydrophones located on the ocean floor. These hydrophones would be under the control of operators in an on-shore or floating command center.

**Up, up, and away**

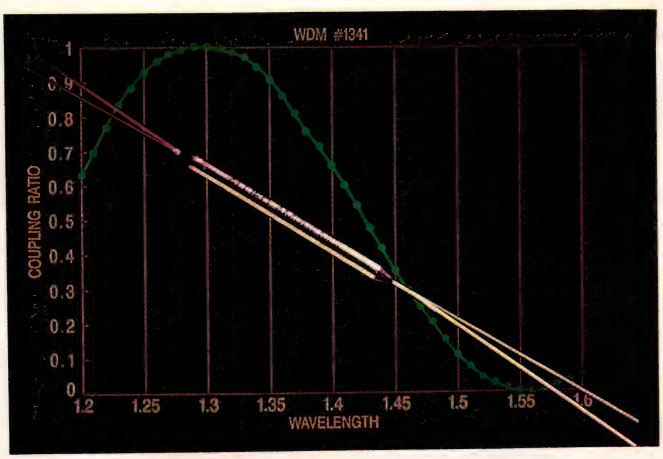
The Air Force's Cruise missile uses a fiber-optic link to connect the transport erector launcher (TEL) to the system's launch control center (LCC). Based on mission and targeting information generated in the LCC, missile firing commands reach the TEL via the optical link. The Air Force is also taking advantage of the inherent security of fiber-optic technology. Air Force Systems Command (AFSC) is developing a fiber-optic cable to allow communication of classified information without use of encryption devices.

Of course, all these military fiber-optic systems are designed around and rely on fiber-optic components. At Corning, the Advanced Fiber Products (AFP) department focuses its R&D efforts on specialty fibers and fibers for use in military and government markets. These specialty fibers include high-strength types for use in tethered systems like Fog-M where operational success depends on a very strong, microbend-resistant fiber.

In addition, AFP produces polarization-retaining single-mode fibers for use in interferometric sensors for weapons, weapons platforms, and navigation systems. Corning makes single-mode fiber designed for operation at various wavelengths, including 633, 850, and 1060 nm. Fiber optimized for 850 nm finds its way into amplitude and interferometric sensors and into specialized communications applications such as high-speed short-wavelength data buses. AFP also markets radiation-hardened optical fiber for applications where exposure to nuclear radiation is a concern, such as in strategic communication systems.




***Placing no restrictions on input data format,*** *Honeywell's HFM Series low-profile transmitter and receiver modules accommodate dc to 25M-bps rates and feature user-selectable output power ratings.*

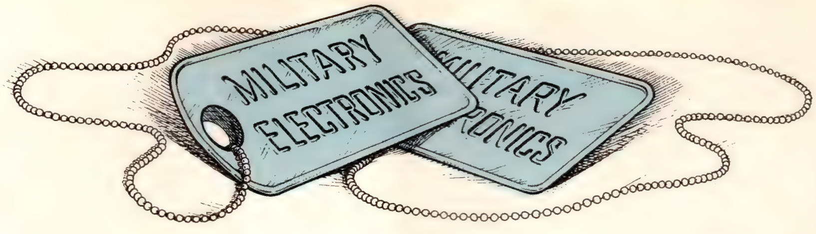



***To double the capacity of a single optical fiber,*** *Amphenol's Interfuse single-mode coupler multiplexes two signals of different wavelengths. Operating in the 1300- and 1500-nm wavelength bands, the coupler specs an excess loss of less than 0.5 dB and has 20-dBm wavelength isolation over a 20-nm bandwidth.*

AFP is in the process of developing hermetic-coated Corguide fibers for use in harsh environments or in applications requiring long service life or high strength —tethered weapons, underwater and land-based tethered vehicles, weapons systems, and other military tactical and strategic installations. The hermetic coating improves the fiber's long-term strength retention by reducing its susceptibility to fatigue, and the proof stress equals 250k psi.

In underwater applications, the Corguide fiber's ability to resist increases in attenuation caused by hydrogen diffusion is an important factor. In long-term testing, these hermetic-coated fibers show very little overall increase in attenuation, and no measurable increase at the common operating wavelengths of 850, 1300, and 1550 nm.

Flight Light cables from Brintec's Brand-Rex Div have an upper temperature spec of 200°C. As a result, they are suitable for jet-engine compartments where fiber-optic cable has until now been unable to withstand the high temperatures. The Flight Light cables' low-temperature spec is −65°C. Designed according to the




flammability requirements of MIL-W-22759/15, the cables have a flame-retardant internal tube and an outer jacket of cross-linked Tefzel or high-temperature fluoropolymer. Cable qualification tests include accelerated aging at 220°C for 1000 hours, which translates into a 4000-hour survival figure at 200°C.

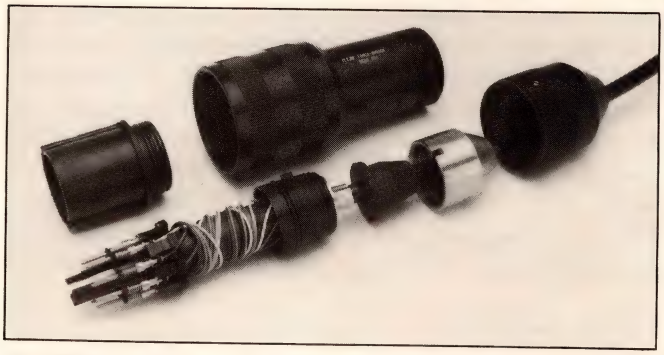
The cables offer another advantage as far as aircraft applications are concerned because they weigh only 3.7 pounds per 1000 feet. You have a choice of 1- or 2-fiber cables and core/cladding ratios of 50/125, 100/140, or 200/400 μm. Maximum attenuation equals 15 dB/km at 850 nm and 10 dB/km at 1300 nm. The vendor will provide cable assemblies containing commercially available high-temperature connectors. If you assemble the cables yourself, however, you must use a special EPO-TEK 330 or 335D epoxy at all cable termination points. Flight Light cables cost $4 to $5/meter (1000 meters).

**Connectors have no harsh-environment drawbacks**

As with optical fibers and cables, connectors are also becoming attractive to military-system designers. Augat's SMA-style JSC and DSC connectors adhere to MIL-C-83522. Available in nickel-plated brass or stainless alloy, they have a proprietary captivated alignment bushing that ensures a reliable interconnection. This bushing also protects the fiber ends by maintaining precise end separations. The connectors' knurled-nut and crimped-shell design eases the field-termination process also.

Both styles of connectors accommodate fibers with core/cladding sizes of 50/125, 65/125, 85/125, 100/140, or 200/230 μm. The JSC units are intermateable with Amphenol's 906-style connectors. When used with 50-μm core fibers, they spec a typical insertion loss of 0.4 dB and a repeatability of 0.1 dB. The DSC parts are intermateable with Amphenol's 905-style connectors and similar types and meet the proposed EIA connector standard. Their typical insertion-loss and repeatability figures are 0.6 and 0.2 dB, respectively. The operating range spans −20 to +80°C, and you can expect a service life of 100 matings. Both types cost the same: $14.18 for brass and $16.20 for alloy.

ITT Cannon's FOMC Series connectors are also easily terminated in the field. These multifiber connectors are capable of withstanding rough handling and weather extremes, and they boast elastomeric cable and interface sealing, an interface to prevent optical-contact damage, a removable front insert for easy optical-contact cleaning, an anodized shell finish, and an attached dust cap.



***To withstand the rough military environment,*** *ITT Cannon's FOMC Series connectors incorporate elastomeric cabling and interface sealing, an interface to prevent optical-contact damage, an anodized shell finish, and a dust cap.*

Connector contacts have a hermaphroditic design so plugs can mate with other plugs as well as receptacles. The connectors' fiber-flexure chamber protects the terminated fiber from tensile loads. It also provides enough surplus fiber to let service personnel reterminate one or more fibers one time without reterminating the cable's strength member.

Two-, 4-, and 8-channel connectors are available. If you want to provide for future system expansion, you can use an 8-channel connector with fewer than eight fibers and not compromise connector performance: Plugs are available that allow you to seal off unused contact areas. The connectors' nominal insertion loss equals 1.2 dB, their mating life translates to 200 cycles, and their operating range covers −40 to +68°C. A 2-channel plug sells for $140 (100).

**Couplers ease interconnection problems**

As far as fiber-optic couplers are concerned, a number of types are suitable for military applications. WDM (wavelength division multiplexing) couplers, for instance, combine or divide signals of different wavelengths onto or from a single optical fiber, providing a bidirectional data link. Because WDM couplers provide this link using only one fiber, they are well-suited to fiber-optic guided-missile applications. As a missile seeks a target, the link transmits video images from a camera mounted on the missile (as well as other sensor information) back to the ground station. Likewise, the ground station can send signals back to the missile.

Single-mode couplers typically have two military applications: sensing and communications. Sensor applications include gyroscopes (for rotation sensing and navigation), hydrophones (for underwater microphones), and magnetometers (for magnetic-anomaly

*Because of their light weight, fiber-optic cables are well-suited to aircraft applications.*

detection). Ship and aircraft communication systems consisting of single-mode fiber have significantly greater bandwidth capability and are superceding multimode-fiber systems currently in use.

Multimode couplers are still feasible, however. Star and tree couplers are available in different configurations and thus can satisfy a variety of system needs. Star topologies can employ 8, 16, or 32 I/O ports. Multimode couplers also find application in sensors that require beam splitting for multiplexing.

Amphenol Fiber Optic Products offers a cross-section of couplers. Its multimode couplers, the 946 Series, uniformly divides light signals between two fibers. Excess loss specs are 1 dB max, and uniformity and directivity equal 0.5 dB and −40 dB min, respectively. Standard versions of these couplers offer a choice of 50/125-, 62.5/125-, and 100/140-μm pigtails (0.5 meters long). Optional packaging styles include miniaturized, ruggedized, and ruggedized-with-connectors. The miniaturized couplers measure 57×3.4 mm and weigh less than 3g. They operate over −55 to +125°C. The ruggedized and ruggedized-with-connector versions measure 82×16×7 mm and weigh 30 and 50g, respectively. Their operating range spans −40 to +85°C. All couplers in the 946 Series cost $100.

The 945 Series includes single-mode WDM and single-mode tree couplers. The WDM devices use a fuse-taper manufacturing process, which ensures consistent performance in the 1300- and 1500-nm wavelength bands. They come in a 2×2-port configuration and have 0.5m pigtails. The center-wavelength tolerance measures ±5 nm and the bandwidth is 20 nm. Other specs are as follows: wavelength isolation, >20 dB; excess loss, <0.5 dB; directivity, >50 dB.

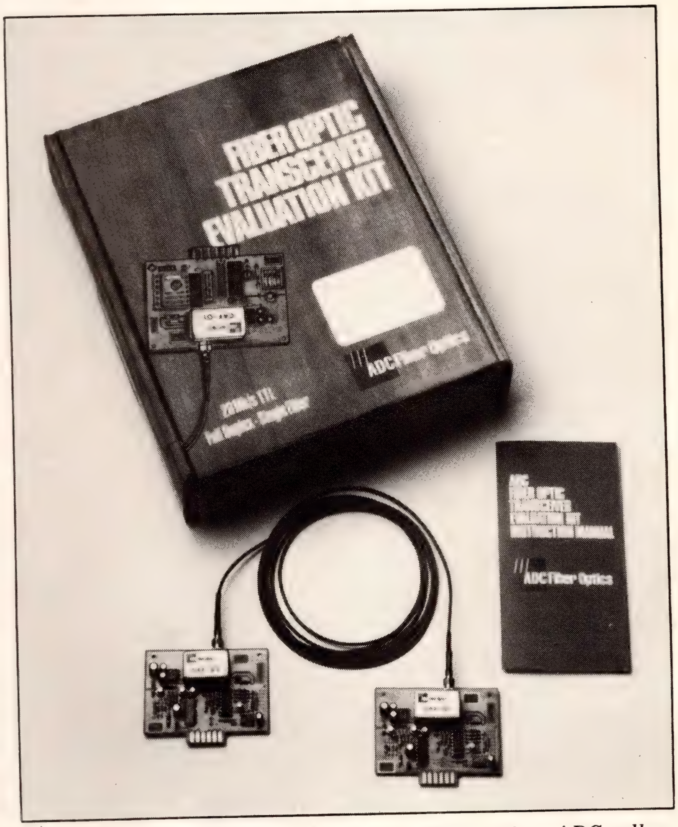
The series' tree couplers are available in the standard 820-, 1300-, and 1520-nm wavelengths and in 1×4- and 1×8-port configurations. These two versions specify maximum excess losses of 0.5 and 1 dB, respectively. Corresponding split ratios are 25 and 12.5%. Both units operate over −55 to +125°C and have a minimum directivity of −40 dB. Like the 946 Series, the 945 couplers sell for $100.

Celwave Valtec also offers a broad line of optical couplers, including multimode transmission-star couplers, single-mode couplers, multimode data-bus tap couplers, and equiport couplers. T-7000 Series transmission-star couplers accept light at a designated input port and distribute it uniformly to designated output ports. Enclosed in aluminum packages, these devices are vibration, shock, and environmentally tested to applicable military specifications. Standard units are available in 2×2-, 3×3-, 4×4-, and 8×8-port configurations. All are pigtailed to 1m lengths of either 50-, 62- or 100-μm multimode fiber. Respective nominal insertion-loss and maximum excess-loss figures span 4 to 11 dB and 2 to 3 dB. The nominal uniformity factor specification is 11%.

In addition, the series includes two custom couplers pigtailed to 50-μm fiber. The 16×16-port model has a 14-dB insertion loss, a 3-dB excess loss, and a 16% uniformity factor. Corresponding figures for the 32×32-port model are 17 dB, 3 dB, and 25%.

T-7269 single-mode couplers are environmentally tested to MIL-T-5422F/AS for shock and vibration and are capable of operating over −60 to +90°C. The 2×2-port couplers operate at 1300- or 1520-nm wavelengths. They spec a splitting ratio of 50/50, a splitting ratio uniformity of 0.5 dB, and a typical excess loss of 0.1 dB.

Military-system designers are also finding that they can use basic fiber-optic components and still satisfy




***To help designers get acquainted with fiber optics,*** *ADC sells a transceiver evaluation kit that includes the components necessary to demonstrate full-duplex communication over a single optical fiber.*

application requirements. For instance, Devar Inc's Type 539 wide-bandwidth detectors are light-to-voltage converters specifically designed for data links and instruments requiring fast response and maximum signal-to-noise ratio. In addition, they are a vital part of the system that controls the illumination intensity of the heads-up display in the F-14 and F-16 fighter planes. Housed in shielded, hermetically sealed miniature TO-99 packages, the 539 detectors consist of a planar diffused silicon photodiode, a current-mode op amp with a 100-MHz gain-bandwidth product, and a film-type gain-setting resistor.

You have a choice of a detector with an active diode area of 0.8 or 5 $mm^2$, and you also have a choice of bandwidths and sensitivities. For a unit with a 0.8-$mm^2$ active diode area, the available bandwidths are 12, 9, and 4.5 MHz, and the possible responsivities are 18, 30, and 60 mV/$\mu$W. For a 5-$mm^2$ active-area device, bandwidths are 10, 7, and 4 MHz; responsivity options remain the same. Rise times range from 28 to 90 nsec. The detectors spec a slew rate of 35V/$\mu$sec.

Both detectors have a pinout that allows the user to choose output signal polarity, gain and offset adjust, and response compensation. The detectors will respond to most common LED and laser sources with wavelengths of 400 to 1050 nm. Possible supply voltages vary

## Manufacturers of military fiber-optic components

For more information on military fiber-optic components such as the ones discussed in this article, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

**Aborn Electronics Inc**
2108D Bering Dr
San Jose, CA 95131
(408) 436-3444
**Circle No 650**

**AC Interface**
17911 Samplson Lane
Huntington Beach, CA 92647
(714) 841-6090
**Circle No 651**

**ADC Telecommunications Inc**
4900 W 78th St
Minneapolis, MN 55435
(612) 835-6800
TWX 910-576-2832
**Circle No 652**

**AEG Corp**
Box 3800
Somerville, NJ 08876
(201) 722-9800
**Circle No 653**

**American Photonics Inc**
Box 289
Brookfield Ctr, CT 06805
(203) 775-8950
**Circle No 654**

**AMP Inc**
Box 3608
Harrisburg, PA 17105
(717) 986-5106
**Circle No 655**

**Amphenol Fiber Optic Products**
1925 Ohio St
Lisle, IL 60532
(312) 960-1010
**Circle No 656**

**Amphenol Products**
40-60 Delaware St
Sidney, NY 13838
(607) 563-5330
**Circle No 657**

**Andrew Corp**
10500 W 153rd St
Orland Park, IL 60462
(312) 349-3300
**Circle No 658**

**ANT Telecommunications Inc**
211 Perry Parkway, Suite 4
Gaithersburg, MD 20877
(301) 670-9777
**Circle No 659**

**Augat Fiberoptics**
Box 1110
Seattle, WA 98111
(206) 223-1110
TWX 910-443-3040
**Circle No 660**

**Avantek Inc**
481 Cottonwood Dr
Milpitas, CA 95035
(408) 943-4410
**Circle No 661**

**Belden Electronic Wire and Cable**
Box 1980
Richmond, IN 47375
(317) 983-5200
**Circle No 662**

**Brintec Corp**
Brand-Rex Cable Systems Div
1600 W Main St
Willimantic, CT 06226
(203) 456-8000
**Circle No 663**

**Celwave Valtec**
Cable Products Group
7635 Plantation Rd
Roanoke, VA 24019
(703) 265-0600
**Circle No 664**

**Codenoll Technology Corp**
1086 N Broadway
Yonkers, NY 10701
(914) 965-6300
**Circle No 665**

**Corning Glass Works**
Corning, NY 14831
(607) 974-4412
**Circle No 666**

**Deutsch Co**
Box 878
Hemet, CA 92343
(714) 929-1200
**Circle No 667**

**Devar Inc**
706 Bostwick Ave
Bridgeport, CT 06605
(203) 368-6751
**Circle No 668**

**Dorran Photonics Inc**
81 First Ave
Atlantic Highlands, NJ 07716
(201) 291-8103
**Circle No 669**

**DuPont Connector Systems**
515 Fishing Creek Rd
New Cumberland, PA 17070
(717) 938-6711
**Circle No 670**

**EG&G Inc**
35 Congress St
Salem, MA 01970
(617) 745-3200
**Circle No 671**

**Eotec Corp**
420 Frontage Rd
West Haven, CT 06516
(203) 934-7961
**Circle No 672**

**Ericsson Lightwave**
Box 4405
Overland Park, KS 66204
(913) 541-7500
**Circle No 673**

**FiberCom Inc**
Box 11966
Roanoke, VA 24022
(703) 342-6700
**Circle No 674**

**Fiberguide Industries**
33 Poplar Dr
Stirling, NJ 07980
(201) 647-6601
**Circle No 675**

**Fibernetics**
90 Glenn Way, Unit 12
Belmont, CA 94002
(415) 593-9883
**Circle No 676**

**Fotec Inc**
Box 246
Boston, MA 02129
(617) 241-7810
**Circle No 677**

*Today's fiber-optic connectors readily meet the harsh environments encountered in military systems.*

from ±5 to ±20V, and the operating range encompasses 0 to 70°C. Prices range from $45 to $80.

Transmitter and receiver modules are also available that make life much simpler for military-system designers and enhance their designs. Honeywell's HFM Series consists of trilevel transmitters and receivers designed for point-to-point digital data transmission. All modules are housed in metal packages 0.3 in. high. They operate from 5V and come with either SMA or ADM (AMP) optical connectors.

The two transmitter modules, the HFM2010 and HFM2025, contain TTL inputs that drive encoder logic and timing circuits, plus high-current drivers for the manufacturer's Sweet Spot LED. Each transmitter's bipolar Masterslice IC and LED produce an encoded 3-level optical signal independent of data format. Transmission capability can reach 2 km (min). The HFM2010 and HFM2025 operate at NRZ data rates of dc to 10M bps and dc to 25M bps, respectively. Working with 100-μm core fiber, the HFM2010 outputs 10 to 100 μW min, and the HFM2025 outputs 10 to 50 μW min. The typical peak-output wavelength measures 820 nm, and optical pulse widths are 50 and 20 nsec (HFM2010 and HFM2025, respectively).

The line also includes two receivers, both of which have a 24-dB optical-signal range. They both have pin

**General Fiber Optics Inc**
98 Commerce Rd
Cedar Grove, NJ 07009
(201) 239-3400
**Circle No 678**

**General Optronics Corp**
2 Olsen Ave
Edison, NJ 08820
(201) 549-9000
**Circle No 679**

**Gould Inc**
6711 Baymeadow Dr
Glen Burnie, MD 21061
(301) 787-3461
**Circle No 680**

**GTE Products Corp**
2401 Reach Rd
Williamsport, PA 17701
(717) 326-6591
**Circle No 681**

**Harris Corp**
Farinon Div
1691 Bayport Ave
San Carlos, CA 94070
(415) 594-3332
**Circle No 682**

**Honeywell Inc**
Optoelectronics Div
830 E Arapaho Rd
Richardson, TX 75081
(214) 234-4271
**Circle No 683**

**Hughes Aircraft Co**
17150 Von Karman Ave
Irvine, CA 92714
(714) 660-5701
**Circle No 684**

**ITT Cannon**
Box 8040
Fountain Valley, CA 92728
(714) 964-7400
**Circle No 685**

**Kaptron Inc**
3460 W Bayshore
Palo Alto, CA 94303
(415) 493-8008
**Circle No 686**

**Laser Precision Corp**
1231 Hart St
Utica, NY 13502
(315) 797-4449
**Circle No 687**

**Lasertron Inc**
23 Fourth Ave
Burlington, MA 01803
(617) 272-6462
**Circle No 688**

**Lightwave Technologies Inc**
9737 Valjean Ave
Van Nuys, CA 91406
(818) 786-7873
**Circle No 689**

**Litton Poly-Scientific**
Fiberoptic Products
1213 N Main St
Blacksburg, VA 24060
(703) 552-3012
**Circle No 690**

**McDonnell Douglas Optoelectronics**
350 Executive Rd
Elmsford, NY 10523
(914) 345-5850
**Circle No 691**

**Meret Inc**
1815 24th St
Santa Monica, CA 90404
(213) 828-7496
**Circle No 692**

**Optelcom Inc**
15930 Luanne Dr
Gaithersburg, MD 20877
(301) 840-2121
**Circle No 693**

**Optical Cable Corp**
870 Harrison Ave
Salem, VA 24153
(703) 389-9900
**Circle No 694**

**Ortel Corp**
2015 W Chestnut St
Alhambra, CA 91582
(818) 281-3636
**Circle No 695**

**Phalo Corp**
900 Holt Ave
Manchester, NH 03103
(603) 669-4347
**Circle No 696**

**Pirelli Cable Corp**
800 Rahway Ave
Union, NJ 07083
(201) 687-0250
**Circle No 697**

**Rockwell International**
Box 10462
Dallas, TX 75207
(214) 998-2598
**Circle No 698**

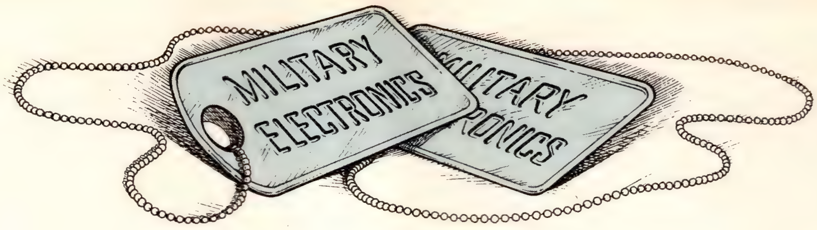
**Siecor Corp**
489 Siecor Park
Hickory, NC 28603
(704) 327-5000
**Circle No 699**

**Souriau Inc**
25158 Avenue Stanford
Valencia, CA 91355
(805) 257-4830
**Circle No 700**

**Spectran Corp**
Box 650
Sturbridge, MA 01566
(617) 765-0851
**Circle No 701**

**Teledyne Philbrick**
Allied Dr at Rte 128
Dedham, MA 02026
(617) 329-1600
**Circle No 702**

**TRW Fiber Optic Products**
401 N Broad St
Philadelphia, PA 19108
(215) 922-8900
**Circle No 703**

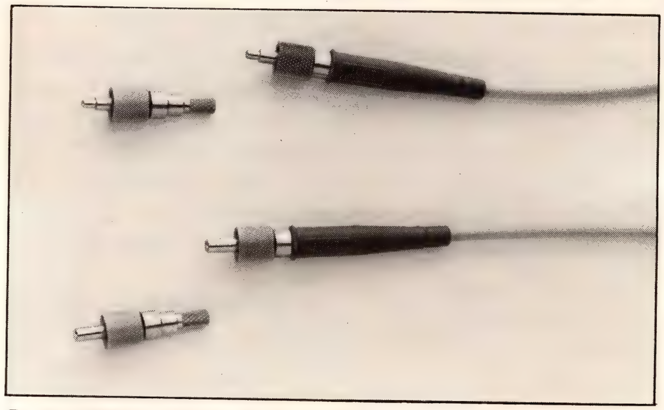



photodiode preamps that drive decoder and timing circuits, plus a TTL output buffer. For $10^{-9}$ BER, the HFM1010 has a sensitivity of −31 dBm, whereas the HFM1025 specifies −25 dBm. They have respective optical rise and fall times of 25 and 10 nsec max. All members of the HFM Series are priced at $120.

Siecor offers transmitter and receiver modules designed for military data communications and housed in hermetically sealed, 20-pin DIPs. The transmitter module converts 100K ECL differential inputs into an optical output with a 1300-nm center wavelength and a typical spectral width of 120 nm. Data rates range from 10M to 200M baud. Internal driver circuits for the GaAsP LED source provide fast optical transition times: Rise and fall times are 2 nsec typ, 2.5 nsec max. The minimum optical output power into 50-, 62-, and 85-μm fiber equals 8, 13, and 19.5 μW, respectively. You can operate the transmitter module from a single supply as long as you maintain the 5V differential between $V_{CC}$ and $V_{EE}$.

The receiver module converts the 1300-nm optical signals into 100K ECL-compatible electrical signals. It contains an InGaAsP pin photodiode, several amplifier stages (including an ac-coupled differential amplifier), and a comparator for digital pulse shaping. As with the transmitter, you can operate the receiver from a single supply as long as you maintain the 5V differential between $V_{CC}$ and $V_{EE}$. Data rates are also the same.

The average optical sensitivity is −34 dBm max, and the optical dynamic range is 20 dB min. Optical rise and fall times range from 0.5 to 1.3 nsec. Loss of sensitivity due to aging and temperature (over the 0 to 60°C range) equals 0.7 dB max. Both of the modules feature optical connectors that comply with IEC/DIN specification BACS-2.5/10M5.5.

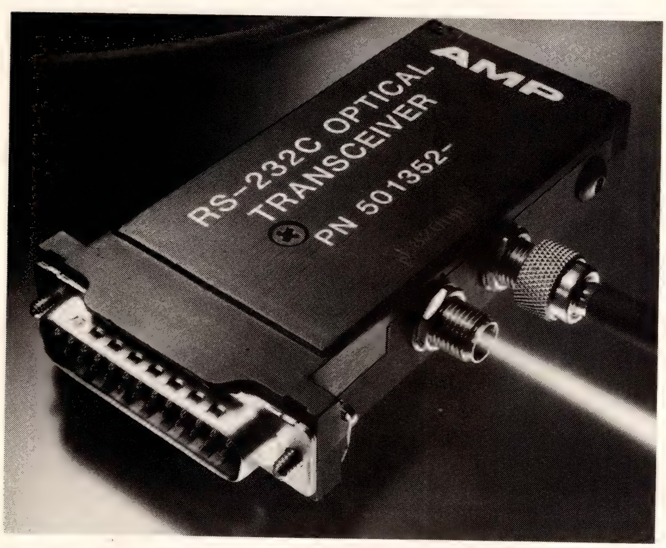


***Designed to meet the requirements of MIL-C-83522,*** *Augat's DSC and JSC Series SMA-style connectors accommodate various fiber sizes and specify low loss figures and high repeatability.*

Litton offers three RS-232C fiber-optic transceivers, which provide full-duplex capability and extend the transmission distance of standard unrepeatered signals to more than 8 km. All units meet MIL-STD-202E requirements for shock and vibration, and they will interface with either DTE or DCE. The EO3675 and EO3672 units provide asynchronous transmissions at data rates to 200k bps, and the EO3671 provides asynchronous/synchronous transmissions at rates to 56k bps. All units spec a BER of $10^{-9}$. Supply requirements are as follows: ±12V dc at 200 mA for the EO3672 and EO3675 and 12V dc at 120 mA for the EO3671. The operating range varies: 0 to 70°C for the EO3672 and EO3675; 0 to 50°C for the EO3672.

The transmitters use a microlensed LED source that emits at a nominal wavelength of 840 nm. The typical optical output power varies with the fiber transmission media, ranging from 30 μW using 50-μm core fiber to 950 μW using 200-μm core fiber. The receivers have pin diode detectors and spec sensitivities of −38 dBm (EO3672 and EO3675) and −45 dBm (EO3671). A 25-pin D subminiature connector provides the electrical interface; SMA-compatible connectors, which accommodate 50/125-, 62.5/125-, 85/125-, or 100/140-μm fiber, provide the optical interface. The EO3671 costs $999; the EO3672, $349; the EO3675, $399. All prices are quoted per set in quantities of 100.

To help designers get familiar with fiber optics, ADC




***Capable of converting standard RS-232C ports to fiber-optic transmission,*** *AMP's transceivers are powered from signals normally found on the RS-232C interface and require no additional power source.*

# Our high-performance family takes the A&D industry to new heights.

Fairchild's Aerospace & Defense strategy is simple:

Take the high ground with high-performance, high-reliability product lines. Provide military superiority in applications ranging from communications satellites to C$^3$I. And offer extra services, like our FAIRTECH™ Design Centers – equipped to turn your ideas into reality in record time.

In microprocessors, for example, our 16-bit F9450 is the fastest, off-the-shelf, mil-temp, single-chip CPU implementing the MIL-STD-1750A ISA.

In linear, we're the world's largest supplier of JAN QPL devices, with over 60 circuit/package combinations: op amps, comparators, voltage regulators, special function circuits, and LCCs and Custom Level S Flow.

Memory products? We're a leading supplier of JAN-qualified TTL RAMs and PROMs, and offer an 883C-compliant CMOS 64K static RAM with a data-retention version.

And in logic, our FACT family is the industry standard for advanced CMOS – ultra-low power consumption, superior speeds, radiation tolerant, MIL-STD-883C compliant and available as Standard Military Drawings. We also offer the industry's broadest FAST™ product line, with devices qualified from MIL-STD-883C to JAN Class S. Plus a full spectrum of Low Power Schottky and Standard Logic.

Each Hi-Rel part comes in a variety of packages conforming to JEDEC and MIL-STD-883C, assembled and tested in state-of-the-art, dedicated A&D facilities. And they're backed by world-class engineering, testing, sales, service and delivery.

For more information, call The Fairchild Customer Information Center at 1-800-554-4443.

**AEROSPACE AND DEFENSE**

We'll help you get your Aerospace & Defense designs off the ground.

**We're taking the high ground.**

**FAIRCHILD**

A Schlumberger Company



*NDI Off-The-Shelf Systems* **NOW!**

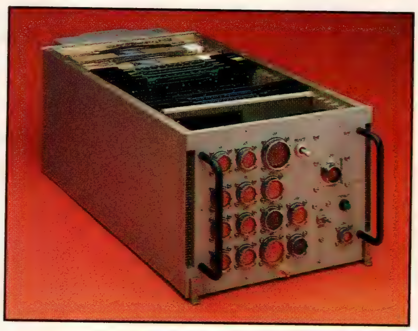
# COMMUNICATIONS NETWORKING THAT REALLY WORKS!

## TITAN/SESCO MILITARIZED COMPUTERS

Handle all communications problems, from simple to complex networking, with the high powered SECS 86 Communications Computer, a member of the turn-key family of Severe Environment Computer Systems from TITAN/SESCO.

### COMPLETELY SELF-CONTAINED SYSTEM

The SECS 86 Communications Computer intelligently manages eight HDLC/SDLC Serial Channels, and supports RS232C or RS422A interfaces, asynchronous, bisynchronous, half/full-duplex, NRZ, NRZI, or FM Encoding/Decoding operations. Complete Built-In-Test is standard. Down-load test and additional serial channels are available options. It is available with RMX,™ VRTX™ or other popular Real-Time operating systems, and offers features and expandability options unsurpassed by any other system.



SECS 80 FULL ATR

### X.25 COMMUNICATIONS COMPUTER SYSTEM

When the X.25 firmware package is included, it transforms the SECS 86 Communications Computer System into an X.25 Communications Engine which fully conforms to CCITT X.25 recommendations. The software is Defense Data Network (DDN) qualified to handle communications details for ISO layer 1, 2 and 3, and to directly connect to a Packet Switching Network. Multiple host capability can set a virtual circuit and communicate at the process level or as a remote PAD with log-in capabilities to a local host.

*Solve any high performance problems TODAY...with the SECS 86 Communications Computer!*

™ RMX86 is a trademark of the Intel Corporation
™ VRTX is a trademark of Hunter & Ready

**TITAN**
**SEVERE ENVIRONMENT SYSTEMS**
A Subsidiary of the Titan Corporation

**CIRCLE NO 66**

**20151 Nordhoff St., P.O. Box 2668 • Chatsworth, CA • 91313-2668 • In CA (818) 709-7100/Telex 69-1404**

**800-423-5527**

sells a transceiver kit for $495 that includes all the components required to evaluate full-duplex communications over a single fiber. The kit includes two TTL-compatible transceiver boards, a 3m length of connectorized fiber cable, and an instruction manual.

The transceiver's CAF coupler provides full-duplex transmission capability. The device has a high-precision plastic molded body and integrally molded parabolic mirrors to communicate full-duplex information over a single fiber. The CAF is easy to use because it comes with a premounted LED source, a pin detector, and either an SMA or ST connector. Each transceiver operates from a 5V supply (200 mA typ). The typical bandwidth (for NRZ data) is 2M bps, and the duty cycle equals 50%. The optical power budget is 11.5 dB min. The BER equals $1 \times 10^{-9}$ min.

The transmitter section couples a minimum of 50 $\mu$W (−13 dBm) into a 100/140-$\mu$m graded-index fiber. The receiver section's saturation power equals 150 $\mu$W (−8.2 dBm), and the receiver sensitivity (at 20M bps data rates) equals 3.5 $\mu$W (−24.5 dBm). The transceivers operate from 0 to 50°C, and the operating wavelengths are 730 and 865 nm.

AMP's Optimate transceivers offer the security, electrical isolation, and EMI immunity inherent in optical data transmission, as well the small size designers expect from fiber optics. They are available in metal cases, making them suitable for use in Tempest applications that mandate secure communications. A subminiature D connector interfaces with an RS-232C port on the equipment; I/O ports on the transceiver provide the fiber-optic link via a standard Optimate connector. The units draw power from the RS-232C handshake lines and don't require an independent power source.

They operate at the 850-nm wavelength and are compatible with all standard fibers, including 80/125, 62.5/125, 85/125, 100/140, and 200/230 $\mu$m. Their power budget is 17 dB. When operating at 19.2k bps, the units can transmit 2 km. The ±4V electrical outputs ensure compatibility with most RS-232C equipment. You have a number of options to choose from: either a plug or a receptacle for the RS-232 connector; a switch for selecting either DTE or DCE; and a choice of Simplex, FSMA, or 2.5-mm bayonet connectors instead of the Optimate. The transceivers are priced at $122 (50).

**EDN**

Article Interest Quotient (Circle One)
High 491 Medium 492 Low 493

# ONLY ONE OPTOCOUPLER ELIMINATES LOGIC INTERFACE PROBLEMS.

Logic interface causing confusion?

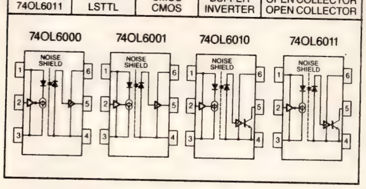
Pull yourself together. Use General Instrument's Optologic™ Optocoupler.

## The First Logic Look-Alike.

Our Optologic™ is the first optocoupler that looks exactly like a common 74-series logic gate at both input and output. For both CMOS and TTL. So it's easy to design in and specify. Without all that trial and error.

**AVAILABLE CONFIGURATIONS**

| PART NUMBER | LOGIC COMPATIBILITY | | LOGIC FUNCTION | OUTPUT CONFIGURATION |
|---|---|---|---|---|
| | INPUT | OUTPUT | | |
| 74OL6000 | LSTTL | TTL | BUFFER | TOTEM POLE |
| 74OL6001 | LSTTL | TTL | INVERTER | TOTEM POLE |
| 74OL6010 | LSTTL | CMOS | BUFFER | OPEN COLLECTOR |
| 74OL6011 | LSTTL | CMOS | INVERTER | OPEN COLLECTOR |




It reduces parts count and board space, too. Because our convenient, 6-pin package has everything.

## Protects You From Noise.

With Optologic™ you get 15 kV/μs common mode transient immunity. 2500 VAC RMS isolation. Propagation delay of 60 ns. And datacom support to typically 15 Mbaud. That adds up to excellent noise rejection, insulation, and high data speeds.

Plus consistent performance over time and temperatures.

## Call And Face The Facts.

Don't waste time withanything else. Optologic™ is faster to design in. Contact your distributor for data and samples. If you prefer, call or write General Instrument, Optoelectronics Division, 3400 Hillview Avenue, Palo Alto, CA 94304. (415) 493-0400.

And never face interface problems again.

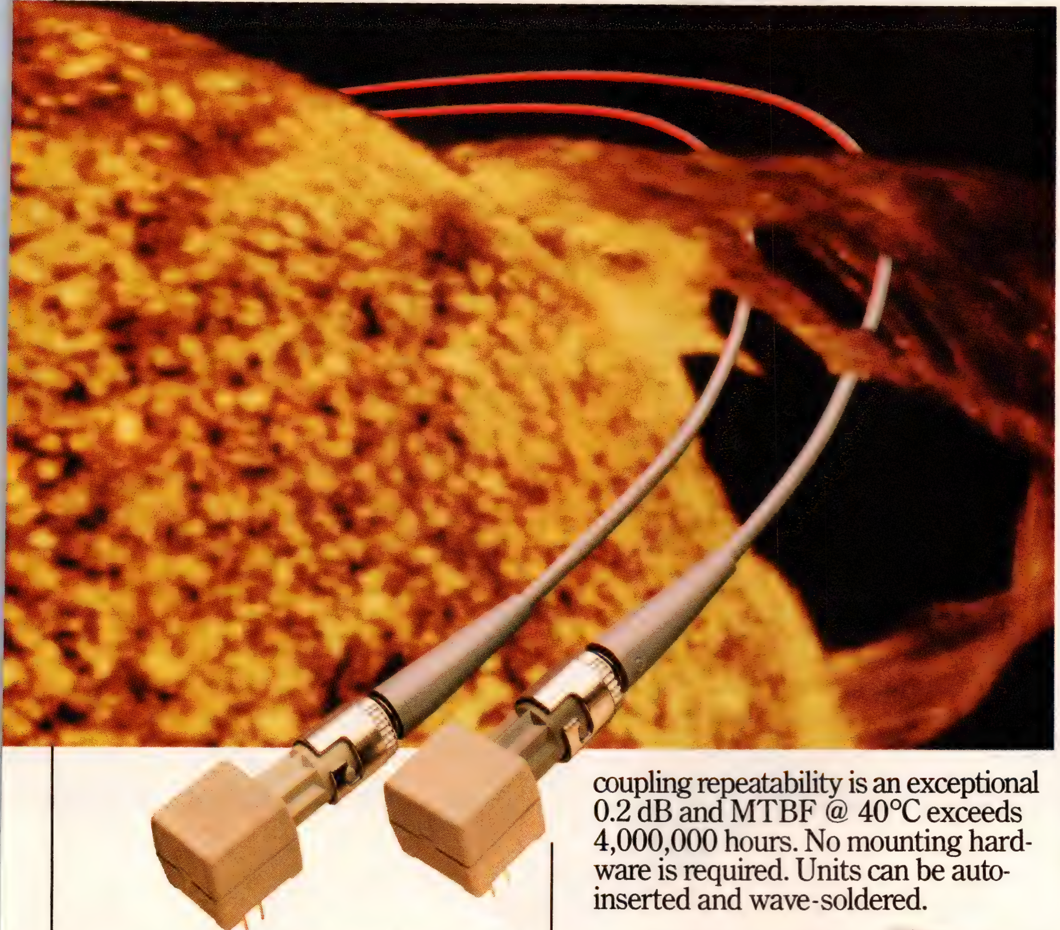
**GENERAL INSTRUMENT**
Optoelectronics Division

**Distributors:** Arrow, Bell Industries-Graham Division, CAM/RPC, Future, Hammond, J.V. Electronics, Kierulff, Milgray, Newark, Pioneer, Summit, Wyle.
**In Canada:** Arrow, Cardinal Industrial, Future, ITT Multicomponents-RAE.



**CIRCLE NO 65**

# *Hot performance. Cool pricing. Easy mounting. Complete your ST* links with HP's sizzling new transmitters and receivers.*



Have you been looking for the convenience of the ST Connector, HP quality and affordable pricing? Look no more. The DC to 50 MBaud performance, uniquely efficient optics and 4 km range of Hewlett-Packard's fiber optic transmitters and receivers have already made them a designer's favorite. Now they are available for use with the popular spring-loaded, quick-twist ST Connectors at extremely competitive prices: as low as $12.50 in quantities of 1,000.‡

HP's ST transmitters and companion ST receivers are completely specified with 62.5/125, 100/140 and 50/125 $\mu$m fiber sizes. For transmitters, coupling repeatability is an exceptional 0.2 dB and MTBF @ 40°C exceeds 4,000,000 hours. No mounting hardware is required. Units can be auto-inserted and wave-soldered.

**Fire-you-up sale: 90 days only!**


Save 80% off the regular evaluation kit price! For the next 90 days order the complete HFBR-0410 kit** for just $10.00. (One to a customer, please!) Make checks payable to Hewlett-Packard Company and send with this coupon *and your business card* to Monte Smith, Hewlett-Packard Components Group, 370 West Trimble Road, Mail Stop 91-1G, San Jose, CA 95131.

☐ I'd prefer an SMA connector evaluation kit for $10 instead.

**Kit includes an HFBR-1412 Transmitter, HFBR-2412 5 megabaud TTL receiver, and 3 metres of AT&T's 62.5/125 $\mu$m fiber optic cable with plastic ST ferrules. EDN 082087 CGO8705

*we never stop asking*

*"What if..."*

For more information, call the Hewlett-Packard sales office listed in your telephone directory white pages and ask for the Components Department. To order, contact your nearest HP distributor. In the U.S.; Almac Electronics, Hall-Mark, Hamilton/Avnet, or Schweber. In Canada: Hamilton/Avnet or Zentronics Ltd.

*"ST®" is a registered trademark of AT&T for Lightguide Cable Connectors. ‡U.S. list price. CGO8705

HEWLETT PACKARD

# More options for every design. Every mode. Everybody's need for practical solutions.

*AMP offers the widest range of cable assemblies, cables and products from board level to network level implementation.*


AMP and OPTIMATE are trademarks of AMP Incorporated.

Now AMP makes it easier to design with fiber optics. And to bring fiber optics into practical application. With the broadest selection of single-mode and multi-mode interconnect products available anywhere.

The newest? Our 2.5mm threaded or bayonet styles which offer high performance and intermate with current single-mode connectors.

Cable and cable assemblies. Connectors and splices. Active device mounts. Transmitters, receivers and transceivers. And the technology you need—board level to network level—to create and maintain your entire system.

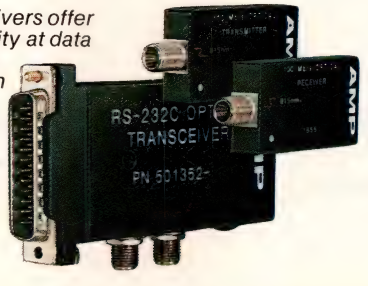
And—as you might expect from AMP—all our interconnect products and application tooling are designed for simplicity, precision and speed. Just the practical help you need to put bright ideas to work.

**Call (717) 780-4400 and ask for the AMP OPTIMATE Information Desk. Or write AMP Incorporated, Harrisburg, PA 17105-3608.**

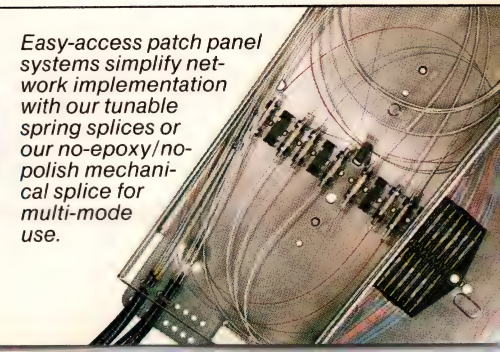
**CIRCLE NO 63**

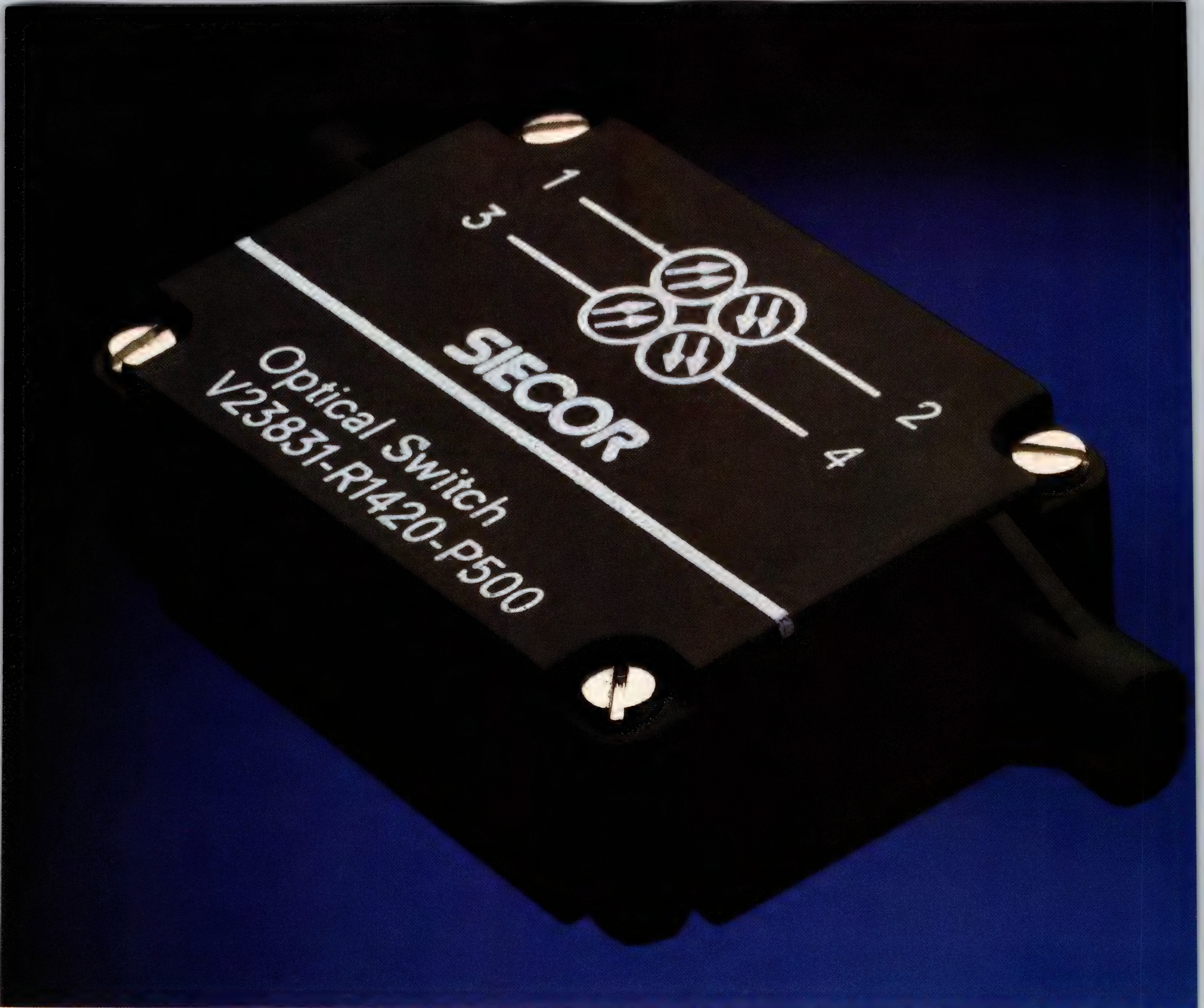
**AMP Interconnecting ideas**

*Transmitters and receivers offer logic level compatibility at data rates from 25 Mb/s to 220 Mb/s. Available in either short or long wavelengths. Transceiver plugs into a standard RS-232 port for instant fiber optic capability.*




*Easy-access patch panel systems simplify network implementation with our tunable spring splices or our no-epoxy/no-polish mechanical splice for multi-mode use.*






# We Tried A Hundred Million Times To Get This Switch To Fail.

To prove its repeatability, we subjected our fiber optic switch to a hundred million operations in laboratory tests. And true to form, it maintained 0.1 dB repeatability at a typical insertion loss of 0.7 dB. And not just any switch can do that.

But our switches pass tough environmental tests such as vibration, shock and temperature extremes. They offer high switching rates. And they're so flexible they can be used in 850 nm or 1300 nm wavelength systems. They're also available in all popular fiber sizes. And they come in a compact, lightweight package.

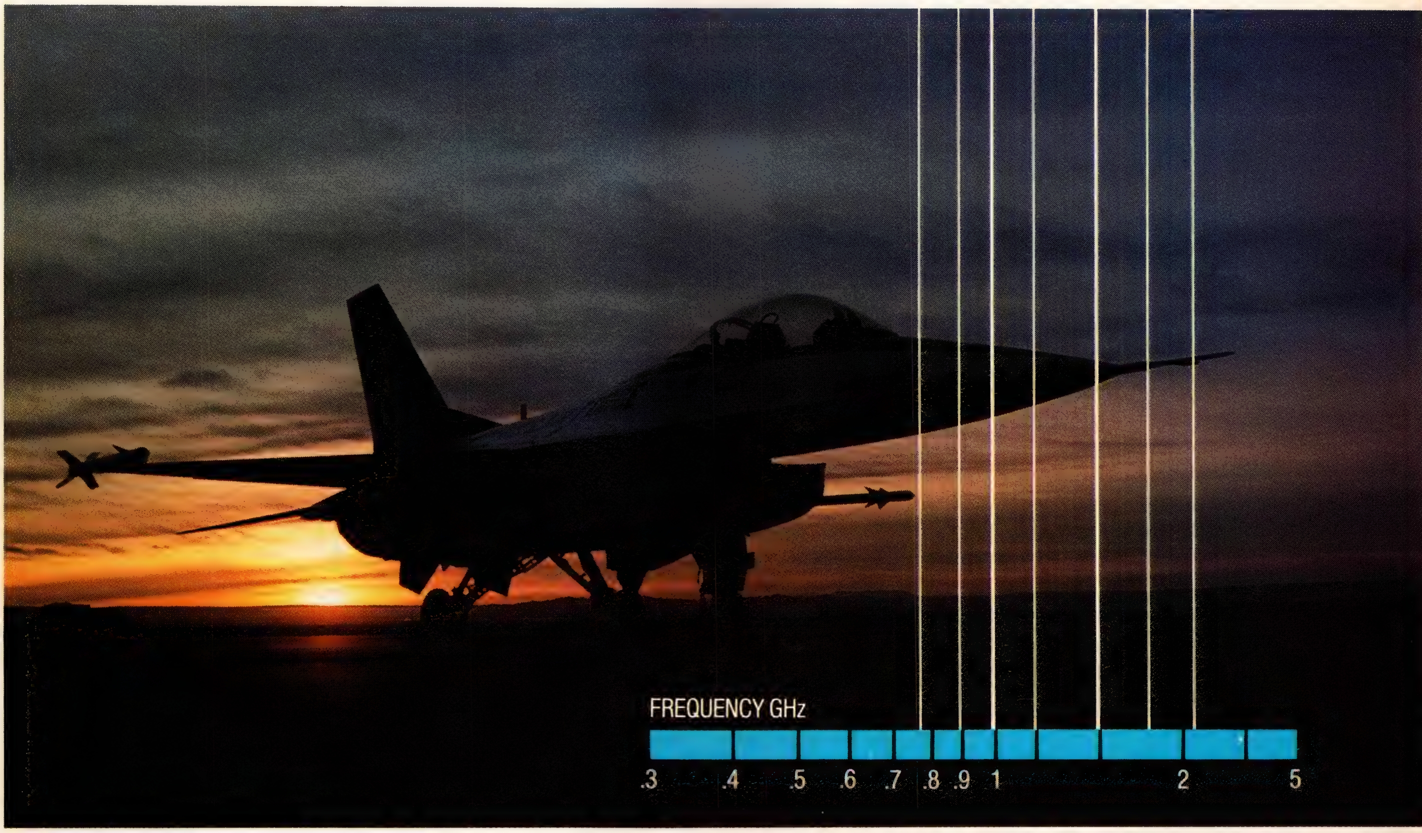
We offer this kind of performance and practicality in all our electro-optic products including our high speed data links, clock recovery modules, clock oscillators, parallel/serial converters and fiber optic modems (RS232, RS422 and TTL).

To find out all the reasons you should be using Siecor components, get in touch with us soon. And we'll give you about a hundred million of them. Write Siecor Corporation, Electro-Optic Products, P.O. Box 13625, Research Triangle Park, North Carolina 27709-3625. Or call 919 549-6571.

SIECOR

CIRCLE NO 62

# In your frequency range, but not out of your price range.




**Introducing the first high-performance 2 GHz signal generator under $11,000.**

If you're expanding your testing capabilities in the up to 2 GHz range, or updating older equipment, our new 6062A offers an outstanding value. With high accuracy, low noise signals, and AM, FM and PM modulation, this new synthesized signal generator keeps the price of quality production testing surprisingly low.

The 6062A is the only signal generator in its price range that also offers high-speed pulse modulation as a standard feature. So you can test radar and avionics transponders without paying a premium. Very high on-to-off ratios (80 dB minimum) and very fast rise times (15 ns) are made possible by new gallium arsenide switching technology.

For low-cost convenient maintenance, you can do on-site calibration yourself—manually or over the IEEE bus. The 6062A is based on the highly reliable 6060B, proven in thousands of installations at manufacturing facilities worldwide. And like all Fluke instruments, the 6062A is backed by Fluke service, training and our exclusive fast-turnaround modular exchange program for emergency repairs.

Contact your local Fluke Sales Engineer or call **1-800-426-0361.** High performance is now in your frequency range. And in your price range.

**Fluke 6062A**

| | |
|---|---|
| Frequency Range | 100 kHz to 2100 MHz |
| Amplitude range | −147 to +13 dBm |
| Spurious | −60 dBc (to 1050 MHz) |
| Residual FM (500 MHz) | 6 Hz in 0.3 to 3 kHz BW |
| Modulation | AM, FM, PM, pulse |

FLUKE®

**IN THE U.S. AND NON-EUROPEAN COUNTRIES:** John Fluke Mfg. Co., Inc., P.O. Box C9090, M/S 250C, Everett, WA 98206. Sales: (206) 356-5400, Other: (206) 347-6100.
**EUROPEAN HEADQUARTERS:** Fluke (Holland) B.V., P.O. Box 2269, 5600 CG Eindhoven, The Netherlands (040) 458045. TLX: 51846.
 Ad No. 2942-6062.

CIRCLE NO 61


# The future: interconnection components designed, manufactured, fabricated and tested under one roof. Here now, at Hughes.

One-roof capability means you can expect higher reliability, lower cost and faster response for your aerospace/mil applications.

We provide system support in the integration of connectors and boards, cables or other subassemblies, including black boxes. And we're doing it now, not waiting for the future.

Our engineers simplify tough problems. But just because we're problem-solvers doesn't mean we ignore ordinary connectors or flex circuitry.

We manufacture everything from PCs to fiber optics to umbilicals. Rectangular, circular, off-the-shelf or specials.

Flexible or rigid flex circuitry? We practically invented it. We'll manufacture to your specs or design it to your requirements. We'll even assemble Brand X connectors and our flex.

So whether your interconnection requirements are simple or sophisticated, give us a call. We can make the future work for you today.

For more information, call Mike Howett, 714-660-5702. In England call Hugh McInally, 0932 47262.

**HUGHES**
AIRCRAFT COMPANY

**CONNECTING DEVICES DIVISION**
Industrial Electronics Group

**CIRCLE NO 60**


# Choose Ada compiler carefully for simulator software

*Training simulators have stringent real-time requirements, and Ada compilers and development tools differ as to how well they can implement the features simulator programs need. By identifying simulator-program requirements, you can evaluate how well specific Ada compilers and tools will suit these and other real-time applications.*

Matt Narotam, Cliff Layton, and John Slish,
*Burtek Inc*

Military training simulators have stringent real-time requirements. Ada compilers and Ada development tools, however, differ as to how well they can implement the features needed for simulators and simulator software. To complicate the matter, no definitive standards yet exist by which you can evaluate these Ada tools for your training-software purposes. By identifying the special requirements of simulator programs, you can evaluate specific Ada compilers and tools for their usefulness in these and other real-time software applications.

Ada, which the Department of Defense has designated as the mandatory language for embedded systems, provides building-block constructs called "packages." Theoretically, these packages would allow you to merge a set of pretested, effective programs with some application-specific code, so that you could develop a bug-free system in much less time than you could with another language. What's missing from this attractive picture is a set of standardized design guidelines and software-engineering tools—in short, a standardized and effective Ada software-support methodology.

Although the Ada Joint Program Office (AJPO) has established working groups to develop the necessary standards, standardization has not yet reached the stage at which you could expect to link program modules from many sources without encountering problems. Even the most basic tools, the compilers, differ so much in the way they implement features of the Ada language that you have to choose your compiler with care, particularly if your application will operate in real time.

**Simulators are sensitive to timing issues**

Training simulators are computer-driven, electromechanical devices that must replicate, in minute detail, the look, feel, and responses of a vehicle, ship, airplane, or weapon system, so as to provide the most realistic training that is possible without the use of the actual system. The simulator system must detect the trainee's actions and generate the appropriate responses within a fraction of a second. The system must also be able to simulate dangerous situations (fire, enemy attack, malfunction of vital components). The trainee can then learn and practice the appropriate recovery procedures so thoroughly that they become automatic responses.

To provide these realistic experiences, the computer and software must control a wide variety of electrome-

*Ada's features make for potentially portable software, but the great differences among Ada compilers can sabotage portability.*

chanical and audiovisual devices, and they must perform complex analytical and I/O operations within very tight time constraints. The software required for developing and using a training simulator consists of the following major components:

- A real-time software executive for controlling the simulation program
- System models that interface to a physical replica of the simulated equipment
- Software input and output drivers
- Software-driven instructor and operator stations that link the users to the trainer
- Database software that provides data required by real-time models, such as navigation-radio facilities, landmass features, lessons or exercises, and malfunction characteristics
- Real-time, on-line debugging facilities for monitoring the models during execution
- Support programs and utilities for developing and maintaining the trainer-system software.

Ada is a highly suitable language for writing software for many kinds of training simulators, because it is based on structured programming, loose coupling between modules, the ability to compile modules sepa-

**LISTING 1**

```
--PROGRAM:  REPRESENTATION_CLAUSE-ILLUSTRATOR;
--PURPOSE:  ILLUSTRATION OF REPRESENTATION CLAUSE USAGE IN A PROGRAM;
--DATE:           5-17-85;
--*****PLEASE NOTE:  REPRESENTATION CLAUSE IMPLEMENTATION VARIES
--                   GREATLY ACROSS ADA COMPILERS

with TEXT_IO, SYSTEM;
use TEXT_IO, SYSTEM;
procedure REPRESENTATION_CLAUSE_ILLUSTRATOR is
          package INT_IO is new INTEGER_IO (INTEGER);
          type LEVEL is (OFF, LOW, NORMAL, HIGH);
          subtype TIME_TYPE is INTEGER range 0..8191;
          subtype TEMPERATURE_TYPE is INTEGER range 0..1023;
          subtype PRESSURE_TYPE is INTEGER range 0..63;
          type SENSOR is
                    record
                       STATUS:         LEVEL            :=OFF;
                       TIME:           TIME_TYPE        :=0;
                       TEMPERATURE:    TEMPERATURE_TYPE :=0;
                       PRESSURE:       PRESSURE_TYPE    :=0;
                    end record;
          for LEVEL use (OFF           =_2#000#,
                         LOW           =_2#001#,
                         NORMAL        =_2#010#,
                         HIGH          =_2#100#);

--*****  THIS ILLUSTRATES THE USE OF THE FOR...USE...ENUMERATION CLAUSE;

    for SENSOR use
        record
           STATUS         at 0 range 0..2;      --WORD 0, BITS 0..2;
           TIME           at 0 range 3..15;     --WORD 0, BITS 3..15;
           TEMPERATURE    at 1 range 0..9;      --WORD 1, BITS 0..9;
           PRESSURE       at 1 range 10..15;    --WORD 1, BITS 10.15;
        end record;
--*****  THIS ILLUSTRATES THE USE OF THE FOR...USE...RECORD CLAUSE;

    DATA:  SENSOR;
    for DATA use at 16#200#;
--*****  THIS ILLUSTRATES THE USE OF THE FOR...USE...ADDRESS CLAUSE;

    INPUT_TEMPERATURE:  INTEGER;
    for INPUT_TEMPERATURE use at 16#2000#;
    task DEMO_INTERRUPT is
        entry READ_DATA;
        for READ_DATA use at 16#100#;
```

rately and then link them together, and well-defined interfacing between modules. All of these features enhance the understandability, efficiency, reliability, and easy integration of Ada code modules.

In particular, you can use Ada packages to encapsulate sharable data or code, and you can use the "task" construct for sequencing or synchronizing time-critical operations. Such operations occur in the simulation software as well as in the on-line debugging and testing tools.

Also, you can use the Ada representation specifications and machine-dependent features, instead of using assembly language, for writing routines that are critically dependent on the optimization of execution time, memory space, or I/O operations. To make these routines more portable, you can enclose them in Ada packages and loosely couple the packages to your other software modules.

In theory, then, you can create an inventory of Ada packages and Ada packages containing tasks, which other designers can incorporate in similar applications. To make use of existing packages, you'd merely have to recompile them for the new target machine, substituting new machine-dependent, low-level-I/O packages

```
--*****  THIS ILLUSTRATES THE USE OF THE FOR...USE...INTERRUPT CLAUSE;
    end DEMO_INTERRUPT;

    task body DEMO_INTERRUPT is
    begin
        accept READ_DATA do
           GET(INPUT_TEMPERATURE);
        end READ_DATA;
        delay 20.0;
        --THIS SIMULATES WHAT COULD BE DONE IN PARALLEL WITH MAIN
        --BODY EXECUTION;
    end DEMO_INTERRUPT;

begin
  NEW_LINE;
  NEW_LINE;
  PUT("THE MINIMUM NUMBER OF BITS NEEDED TO STORE AN OBJECT OF ");
  NEW_LINE;
  PUT("TYPE SENSOR IS");
  INT_IO.PUT(SENSOR'SIZE):
--*****  THIS ILLUSTRATES THE USE OF THE SIZE LENGTH CLAUSE;
--*****  BECAUSE OF THE ABOVE USE OF THE FOR...USE ENUMERATION CLAUSE
         AND THE FOR...USE RECORD CLAUSE, THE RESULT OF THIS PUT
--       SHOULD BE 32 (BITS);
  NEW_LINE:
  NEW_LINE;
  PUT("THE INITIAL ADDRESS FOR THE STORAGE OF THE OBJECT DATA IS");
  INT_IO.PUT(DATA'ADDRESS):
--*****THIS ILLUSTRATES THE USE OF THE ADDRESS LENGTH CLAUSE (IT
--     PRESUPPOSES THAT ADDRESS YIELDS AN INTEGER CONSISTENT WITH
--     INT_IO.PUT);
--*****  BECAUSE OF THE ABOVE USE OF THE FOR...USE ADDRESS CLAUSE
--       RE THE OBJECT DATA, THE RESULT OF THIS PUT SHOULD BE 512;
--NEW_LINE;
  NEW_LINE;
  DEMO_INTERRUPT.READ_DATA;
--*****  THIS WILL CAUSE THE INTERRUPT LOCATION 256 TO INITIATE THE
--       EXECUTION OF THE STATEMENT IN READ DATA (AN INTEGER WILL
--       BE GOT INTO INPUT_TEMPERATURE, FOR TESTING PURPOSES);
  PUT(INPUT_TEMPERATURE):
--       THIS WILL PUT INPUT_TEMPERATURE FOR VERIFICATION PURPOSES;
--NEW_LINE;
  NEW_LINE;
end REPRESENTATION_CLAUSE_ILLUSTRATOR;
```

*Training-simulator requirements impose stringent time constraints on the software that drives the simulator.*

where necessary.

In practice, however, you may find it very difficult to integrate packages that were not written for your application or within your particular Ada software-development environment. There are several reasons for the possible difficulties. First, although the Ada language itself is well defined, different compilers often implement some of the language's features differently.

Second, a complete Ada software system for an embedded computer includes a run-time component. The run-time component is an operating system that is stripped down to provide only the services specifically needed by the application; it eliminates the need for a full operating system, such as Unix. The run-time

**LISTING 2**

```
--PROGRAM:   TIMER;
--PURPOSE:   ILLUSTRATION AND CLARIFICATION OF THE USE OF THE ADA
--           PACKAGE CALENDAR, IN A SIMPLE TIMING CONTEXT:
--DATE:      5-17-85;
--*****PLEASE NOTE THAT THE PROGRAM WILL REQUIRE NO INPUT, AND WILL
--         HAVE SYSTEM DEPENDENT OUTPUT;

with TEXT_IO, SYSTEM, CALENDAR;
use TEXT_IO;
procedure TIMER is
     type FLO is digits SYSTEM.MAX_DIGITS;
--THIS WILL ASSURE THE MAXIMUM POSSIBLE FLOATING POINT ACCURACY RE
--CALENDAR.TIME;
  package FLO_IO is new FLOAT_IO(FLO);
--  THIS INSTANTIATION WILL ALLOW THE PUTTING OF FLOATING POINT TIME;
    package INT_IO is new INTEGER_IO(INTEGER);
--  THIS INSTANTIATION WILL ALLOW THE PUTTING OF MAX_DIGITS;
    package FIX_IO is new FIXED_IO(DURATION);
--  THIS INSTANTIATION WILL ALLOW THE PUTTING OF (DELAY) DURATION'SMALL
    START:  CALENDAR.TIME;
    STOP:  CALENDAR.TIME;
begin
    NEW_LINE;
    NEW_LINE;
    PUT("ON THE CURRENT SYSTEM, THE MAXIMUM NUMBER OF FLOATING POINT DIGITS");
    NEW_LINE;
    PUT ("OF ACCURACY IS");
    INT_IO.PUT(SYSTEM.MAX_DIGITS);
    NEW_LINE;
    PUT("ON THE CURRENT SYSTEM THE MINIMUM DURATION IS");
    FIX_IO.PUT(DURATION'SMALL):
    PUT("SECONDS");
    NEW_LINE;
    NEW_LINE;
START
    START := CALENDAR.CLOCK;
    DELAY 10.0;
--  THIS DELAY REPRESENTS THE TIME OF EXECUTION OF THE CODE SEGMENT BOUNDED BY
--  START AND STOP;
    STOP := CALENDAR.CLOCK;
--  STOP
    PUT ("THE TIME OF EXECUTION OF THE CODE SEGMENT BOUNDED BY START AND ");
    NEW_LINE;
    PUT ("STOP IS APPROXIMATELY");
    FLO_IO.PUT(FLO(CALENDAR.SECONDS(STOP)) - FLO(CALENDAR.SECONDS (START)));

    PUT("SECONDS");
--  ONE SHOULD BE SURPRISED IF THIS OUTPUT IS NOT APPROXIMATELY 10.0 SECONDS;
    NEW_LINE;
    NEW_LINE;
end TIMER;
```

## The Ada culture

The DoD's Stoneman document specifies the general requirements for an Ada Programming Support Environment (APSE), which has four levels (ordered from low to high): the host computer's operating system (if any); the Kernel APSE; the Minimal APSE; and the APSE (the term refers both to the total environment and to its highest level). Providing that you conform to these general requirements, you can add features that optimize the APSE for a particular class of applications (such as a training simulator or a space station).


***Fig A—A complete Ada Programming Support Environment (APSE) has four levels:*** *the host computer's operating system (if any); the Kernel APSE, which provides the interface to the operating system; the Minimal APSE, which contains a minimal set of general programming tools; and the APSE, which contains special-purpose programming tools.*

**Fig A** shows a model for an APSE that will allow you to develop simulation software systems. The Kernel APSE serves as the interface between the host computer and the development tools by providing database services, communications, and run-time services. To ensure that the support software will be portable, the high-level side of the kernel must be machine-independent; however, the implementation of the kernel will be dependent on the machine side of the interface to some extent.

The Minimal APSE level should contain a comprehensive set of programming tools, including an editor, a compiler and linker, a debugger, a command-language interpreter, and a configuration manager. All of these tools should have a general-purpose rather than an application-specific nature so that they'll be portable from one APSE to another. They should be written in Ada and should interface to their host computer only through a Kernel APSE.

The highest level of an APSE may contain extensions of the minimal tools, new general-purpose tools, and tools (also written in Ada) that are specific to applications, projects, and programmer preferences. In a simulation APSE, the simulation tools should be placed at this level.

The Common APSE Interface Set (CAIS) is a set of Ada software interfaces, contained in packages, that allow APSEs to share tools and databases. The CAIS should contain a model for administering entities such as processes, devices, files, and directories; a process model allowing access and control; an I/O component allowing device control, character I/O, file I/O, and interprocess communications; and a set of utilities.

Finally, the Runtime Interface Set (RTIS) provides an interface between the APSE tools and the run-time system that will provide basic system services in an embedded system. The run-time system is the least standardized and least advanced component of the Ada culture, but a considerable amount of work on it has already been performed for the DoD, and a run-time-system working group has been established by the AJPO to develop run-time-system concepts and standards.

*The Ada run-time system is the least standardized of the Ada Programming Support Environment components, but it is critical to simulation-software development.*

**TABLE 1—COMPARISON OF ADA COMPILERS**

| | AL | DE | IC | RO | SO | SY | TE | VE |
|---|---|---|---|---|---|---|---|---|
| **REPRESENTATION CLAUSES** | | | | | | | | |
| LENGTH CLAUSES | N | Y | N | Y | Y | Y | N | N |
| FOR. . .USE. . .CLAUSES | | | | | | | | |
| ENUMERATION | N | Y | N | N | Y | Y | N | N |
| RECORD | N | Y | N | N | Y | Y | N | Y |
| ADDRESS | N | N | N | Y | N | N | N | N |
| INTERRUPT | N | N | N | Y | N | N | N | N |
| **IMPLEMENTATION-DEPENDENT FEATURES** | | | | | | | | |
| PACKAGE SYSTEM | Y | Y | Y | Y | Y | Y | Y | Y |
| REPRESENTATION ATTRIBUTES | N | Y | N | Y | Y | Y | N | Y |
| PACKAGE MACHINE CODE | N | N | N | Y | Y | N | N | N |
| GENERIC UNCHECKED DEALLOCATION | Y | Y | N | N | N | Y | N | Y |
| GENERIC UNCHECKED CONVERSION | Y | Y | Y | Y | Y | Y | Y | Y |
| **LOW-LEVEL I/O PACKAGE** | U | U | N | U | U | U | U | U |
| **PRAGMAS** (ALL PREDEFINED) | | | | | | | | |
| CONTROLLED | N | Y | U | N | N | N | N | N |
| ELABORATE | Y | Y | U | Y | N | Y | N | Y |
| IN LINE | N | Y | U | Y | N | N | N | N |
| INTERFACE | Y | Y | Y | Y | Y | Y | N | Y |
| LIST | Y | Y | U | Y | N | Y | N | Y |
| MEMORY SIZE | N | Y | U | N | Y | N | N | N |
| OPTIMIZE | Y | Y | U | N | Y | N | N | N |
| PACK | N | Y | Y | N | N | Y | N | N |
| PRIORITY | Y | Y | U | Y | N | N | N | N |
| SHARED | Y | Y | U | N | Y | Y | N | N |
| STORAGE UNIT | N | Y | U | N | Y | N | N | N |
| SUPPRESS | Y | Y | U | Y | Y | N | Y | Y |
| SYSTEM NAME | N | Y | U | N | Y | Y | N | N |

**OTHER ASPECTS THAT SHOULD BE INVESTIGATED**

| | |
|---|---|
| CODE EFFICIENCY | SYSTEM.MAX DIGITS |
| COMPILER SPEED | SYSTEM.MAX INT |
| DURATION' SMALL | SYSTEM.MAX MANTISSA |
| RUN-TIME SYSTEM | SYSTEM.MIN INT |
| SYSTEM.FINE DELTA | SYSTEM.TICK |

**NOTES:**

| | |
|---|---|
| AL=ALSYS | SY=SYSTEAM (PERKIN ELMER) |
| DE=DEC | TE=TELESOFT (VAX/VMS) |
| IC=ICSC (GOULD, ETC) | VE=VERDIX (HARRIS) |
| RO=ROLM (DATA GENERAL) | Y=YES |
| SO=SOFTECH | N=NO |
| | U=UNKNOWN |

component is not yet standardized, but it will probably consist of a set of Ada packages built into, or accessible by, the compiler. The run-time system will implement a virtual computer that will be adaptable to a variety of processor architectures and will have standard interfaces to the application software. The run-time system is critical to the development of simulation software, and it will have to be tailored to specific and precise simulation requirements, for which standards have yet to be developed.

### Few standards exist for Ada support tools

Third, the software-development environment must include tools such as design aids, editors, debuggers, program-management tools, documentation-control tools, and configuration-management tools. Although the DoD has provided high-level definitions of a typical Ada Programming Support Environment (APSE) (see **box**, "The Ada culture"), the degree of standardization of existing APSE levels varies widely from level to level.

Thus, in the long term, the development of a comprehensive and standardized methodology for Ada software design is critical to the success of Ada as an engineering tool. The ideal route would be to develop the methodology and then use Ada as a tool to implement that methodology. In practice, however, attempts to use this approach have met with little success, particularly for applications that are sensitive to timing issues and processor configurations. More investigation of Ada constructs and their side effects is needed before a fruitful approach to implementing a design methodology can be developed.

Meanwhile, however, there's an urgent need to evaluate existing Ada tools from the standpoint of their suitability for developing training-simulator software. APSE, CAIS (Common APSE Interface Set), and Ada run-time systems are not yet standardized or mature enough to be used as bases for precise and meaningful evaluations of application software. On the other hand, the Ada language itself is standard, and Ada compilers have matured to the point where you can distinguish the differences among them that are pertinent to simulation software either in development or scheduled for the near future.

In the course of an Air Force project that called for Burtek Inc to rewrite (in Ada) and recompile some code that had originally been written in Fortran, we found it necessary to evaluate a number of Ada compilers, placing particular emphasis on the way they implemented certain Ada features that are critical to simulation software.

Because current Ada compilers either vary widely in their implementations of these features, or implement the features incompletely, we used a number of short, simple test programs to differentiate among the compilers. **Listings 1** and **2** are typical examples of the programs in the test suite. The Representation Clause Illustrator program **(Listing 1)** illustrates and tests a compiler's usage of Ada representation clauses. The Timer program **(Listing 2)** tests Ada's predefined Calendar package, the fixed-point Ada type Duration,

# Unleashing a powerful new species of Firebreather. The mini supercomputers from Gould.

There's a vast world of difference between the power of a super minicomputer and our new Firebreathers — the Gould NPL™ family of mini supercomputers. It's a whole new category of compatible Gould computers that bridges the gap between giant supercomputers on the one hand and superminis on the other.

The Gould NPL family offers you the power and speed of supercomputers at the cost of superminis, and they are every bit as easy to use. NP1, the first Firebreather in the NPL family, delivers performance equal to first generation supercomputers.

Harness the power:

- Multiprocessor parallel architecture.
- High performance scalar and vector processing.
- Real memory expandable to 4 billion bytes.
- Industry standard I/O subsystems.
- Continuous throughput 5 times faster than any supermini.
- Gould's proven UNIX®-based operating system, UTX/32®.
- Languages that include vectorizing FORTRAN and highly optimized C compilers, plus Ada®

How you use Gould's NPL family is limited only by your imagination.

Consider this power applied to complex scientific and engineering computations, simulation, real time data acquisition and intensive program development.

If your present computer no longer has the power you really need, get in touch with the future. Get in touch with Gould.

**Gould, Inc., Information Systems**
**Computer Systems Division**
**6901 West Sunrise Boulevard**
**Fort Lauderdale, Florida 33313**
**1-800-GOULD-10, TLX 441491**

**GOULD**
***Electronics***

UNIX is a registered trademark of AT&T Bell Labs.
Ada is a registered trademark of the U.S. Government, Ada Joint Program Office.
NPL & UTX/32 are trademarks of Gould, Inc.

CIRCLE NO 59

*In theory, you can create an inventory of universally reusable Ada packages. In practice, you may have to modify a package before using it.*

and the Ada Delay instruction in a simple context. You could use the two listings to test any Ada compiler for these characteristics.

**Table 1** shows the results of the evaluations. We tested the Telesoft compiler on a DEC VAX 11/780 machine and the Data General compiler on a Data General MV4000 machine. The information relating to the other compilers listed in the matrix comes from compiler documentation and data supplied by the vendors. As you might expect, all the vendors said that "soon-to-be-released" versions would remedy the deficiencies that we detected. Besides showing how well the listed compilers suit training-simulator applications, these results also give an indication of the performance you can expect from the compilers in other applications requiring real-time software performance.

To clarify the table, some explanations are in order. Ada representation clauses specify how a computer should store data. If they're properly implemented, these clauses let you exercise low-level control over the representation of enumeration types and the bit-level storage of record fields.

Implementation-dependent features are listed in Appendix F of each compiler's Ada implementation document, which each compiler vendor generates in order to show how its compiler meets the requirements of the Ada Language Reference Manual (LRM). Among these features, the package system and the representation attributes are particularly important in determining the numeric accuracy and storage of programs compiled with the product. Likewise, the Machine Code package is important for determining how the compiler handles the insertion of machine code, and the generic Unchecked Deallocation and Unchecked Conversion procedures determine how the product exercises control of storage and handles type conversions.

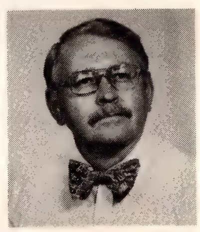
"Pragmas" are instructions to an Ada compiler. Ideally, the compiler you choose should implement all of the predefined Ada pragmas listed in the table in a manner appropriate for flight-simulation software. However, some pragmas are generally not implemented at all, and those that are may vary widely from one compiler to another and may be more or less well suited to your particular application. You may even find that a compiler implements some pragmas in a way that is ideal for you, yet implements others in a disadvantageous manner; in that case, you'll have to choose your compiler on the basis of the tradeoffs involved. Probably the most important pragmas for flight-simulation use are Interface, Priority, and Inline; you should pay most attention to these.

You also need to pay careful attention to the features listed in the table under the heading "Other Aspects," because they differ greatly from compiler to compiler. For any given function, the best Ada compilers generate code that is only about 75% as efficient as the corresponding Fortran code; the worst Ada compilers generate abysmally inefficient code. Their compilation speeds, too, vary from 30 to 1500 lines per minute. Other features that vary widely are the parameters used by the Calendar package, such as DURATION' SMALL and SYSTEM.TICK. These variations are hardly surprising, because Ada-compiler technology is still in a relatively early stage, but they should alert you, as a simulation-software developer, to keep a sharp eye out for less obvious and potentially more troublesome variations. **EDN**

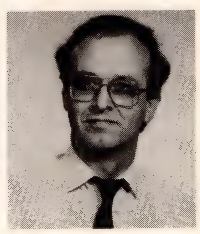
## Authors' biographies


*Matt Narotam is a staff engineer at Burtek Inc (Tulsa, OK), where he's responsible for developing Ada programs. He holds a PhD from the University of Salford, England.*

*Cliff Layton is director of the Computer Science Div of Rogers State College (Claremore, OK). Cliff holds an MS from the University of Oklahoma and is a member of ACM, IEEE, DPMA, and the Unix /usr/group. In his spare time he enjoys backpacking and reading.*



*John Slish is Burtek's support-services supervisor, with responsibility for the company's training programs and publications. He holds a BA in English literature from Oklahoma State University and is a member of the American Society for Training and Development.*




Article Interest Quotient (Circle One)
**High 482 Medium 483 Low 484**

RIFA MICROELECTRONICS DIVISION •

BIG ENOUGH TO COPE • SMALL ENOUGH TO CARE •

Hybrids. For flexible, compact solutions in circuit design. Cost-effective even on short production runs prohibitive for integrated circuits. Rugged. Resistant to heat and suitable for high frequencies. And with packaging possibilities that stretch the imagination.

Bringing your designs to life. Your concepts. Our knowledge. With your experts. Quality control from day one. And commitment to your project success.

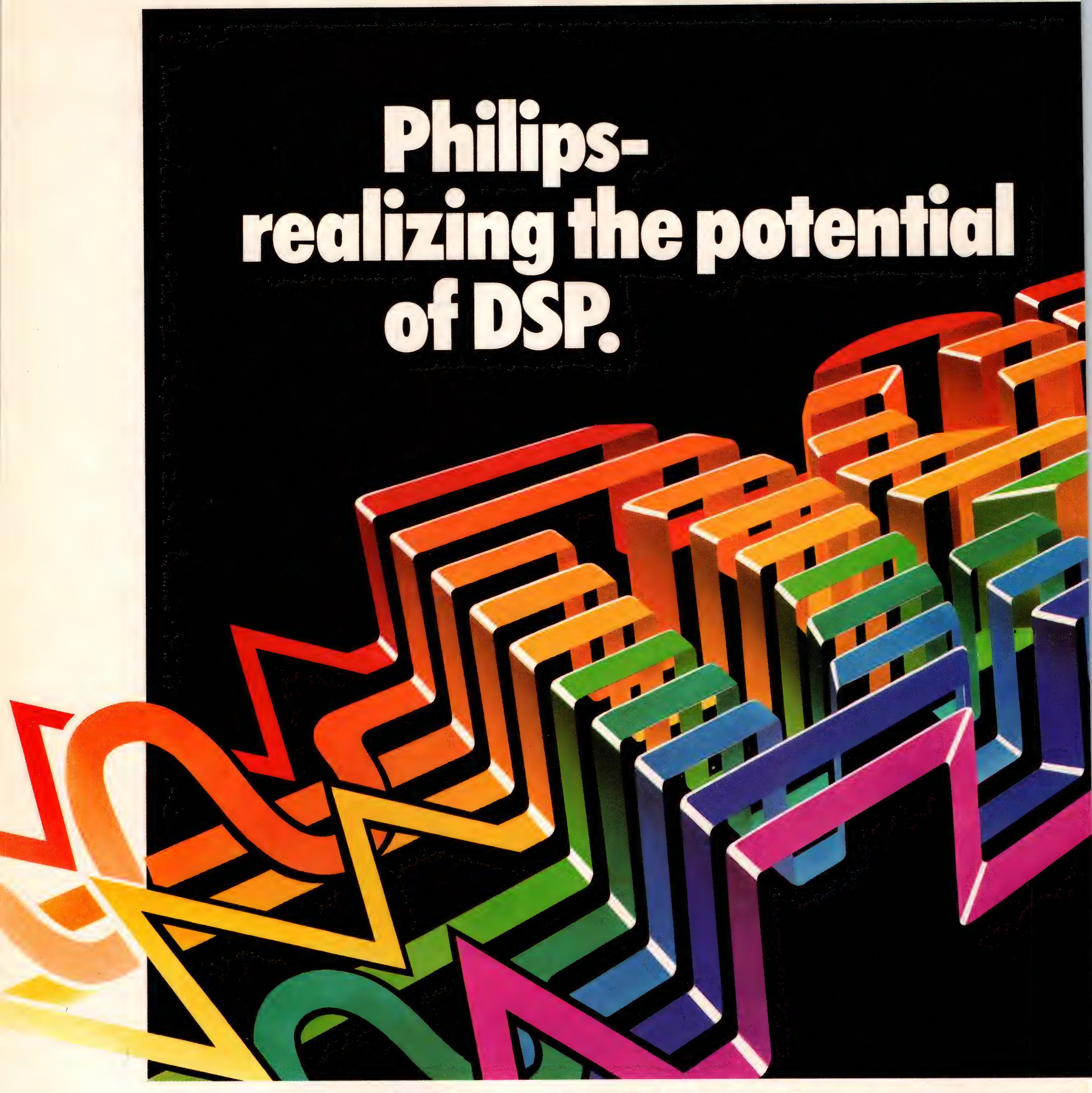
**RIFA**

RIFA AB, S-163 81 STOCKHOLM, SWEDEN, TEL 08-757 50 00
TELEX 13690 ELRIFA-S, TELEFAX 08-752 60 34

CIRCLE NO 57

RIFA MICROELECTRONICS DIVISION •

BIG ENOUGH TO COPE • SMALL ENOUGH TO CARE •



Philips-
realizing the potential
of DSP.

The power necessary for your digital signal processing application just arrived from Philips. Sheer throughput that makes short work of the complex algorithms required for real-time telecoms, speech, image and industrial signal-processing applications.

Throughput power that stems from highly parallel architecture. The DSPs in Philips' new SP50 Family can perform up to six operations every 125 nano second clock cycle, processing signals at up to 48 million operations per second.

But computational power only holds the key to starting a DSP project. Solid partnership with your supplier is necessary to bring the design cycle to a successful conclusion. Designing with DSP needs in-depth support: a complete set of design tools, backed by expert engineering advice, and long-term commitment. That's all part of Philips' business philosophy, and in DSP it's already led to a track record of dozens of projects, and literally millions of ICs.

To find out more about SP50 DSP technology, clip the coupon below:

**SP50 Family single-chip programmable DSPs:**
- CMOS, Harvard architecture two (16-bit data-buses)
- 16 x 16 → 40-bit multiplier/accumulator with barrel-shifter
- separate 2-operand/31-operation ALU
- 3-port/15-register scratchpad file
- three address computation units
- two serial input channels
- two serial output channels
- one or two 16-bit parallel data ports:– 16, or 16 and 9-bit addressing
- maskable interrupt
- instruction repeat mechanism
- instruction and coefficient ROM (PCB5010) and ROMless (PCB5011) versions

**Development support:**
- Cross-assembler
- screen-oriented simulator with ILS interfaces
- extensive source-code-accessible library of filters FFTs etc.
- stand-alone real-time emulator
- application notes

**Application highlights:**
- Fast filter and FFT kernels with amazingly little overhead for initialization and I/O
- easy multi-DSP implementation via flexible I/O capabilities
- combined DSP and controller use by means of separate ALU

Please send me full details of Philips DSPs

Name________________

Position/file________________

Company________________

Address________________

________________ Postcode________

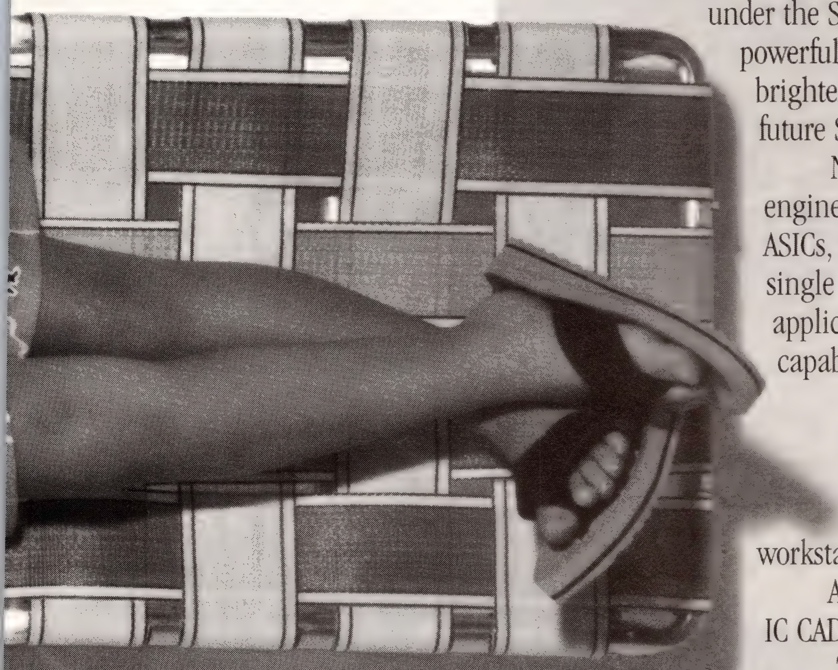
Country________________

EDN 080687


Philips Electronic Components and Materials Division,
Building BA, P.O. Box 218, 5600 MD EINDHOVEN, The Netherlands, Telex 35000 phtc/nl

**The name is Philips.
The product is DSP.**

**PHILIPS**



# Simply Superior

## The SOLTEC SDA2000 Transient Waveform Recorder

### Superior

Recording has never been easier. That means you spend less time programming and more time testing.

The Soltec SDA2000 Transient Waveform Recorder is a "turn-key" system. Just plug in to your IBM PC, XT or AT and follow the menus to record, display, analyze and hard copy your data.

### Simple

The Soltec SDA2000 is faster and smarter than any other PC driven data acquisition system. Simply said, it is superior.

A maximum sampling rate of 200 nanoseconds with 12 bit (0.025%) resolution provides maximum speed and performance.

A 2 megasample RAM is organized as a ring buffer for simultaneous data transfer while recording. Now you can access recorded data while new data is recorded. The DMA transfer is at a 300 KByte per second rate to the IBM PC.

Expand channels to 64 in groups of 8 via a daisy chain configuration. Each analog channel has a bandwidth of d.c. to 3MHz.

Includes a two tier analysis capability via internal and third party software packages.

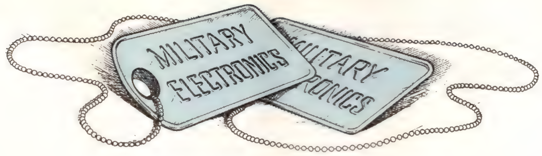
Finally the Soltec SDA2000 comes complete: complete in hardware and complete in software.

Never before have such superior results been so easily attained.

For information call toll free (800) 423-2344 or (818) 767-0044 in California or write SOLTEC CORPORATION, Sol Vista Park, San Fernando, CA 91340.


CIRCLE NO 70

SOLTEC®




# Modularity is key to interfacing to the Defense Data Network

*When designing an interface to connect to the DDN, you're better off using small, independent software modules and separate hardware functions. The modules need to be flexible enough to adapt to future DDN modifications and the probable switch to OSI protocol standards.*

Michael E Kubat, *Unisys Corp*

Anyone who wants to connect data-processing equipment to the Defense Data Network (DDN) must supply a data-network interface that complies with all DDN protocol specifications. This interface can be one of two types. It can be a terminal-emulation processor (TEP), which emulates a virtual terminal to exchange information between a terminal and a host, or it can be a full-service interface, which, in addition to providing terminal emulation, allows different hosts to exchange information.

In any case, your design should have an architecture consisting of layered protocols that decompose the software and hardware into sets of independent modules. This modular approach makes the task of upgrading less complex and is desirable as the Department of Defense gradually phases out older protocols and adopts the newer International Standards Organization (ISO) Open System Interconnect (OSI) protocol standards (see **box,** "DDN protocols correspond to OSI standards").

For example, in the design approach to a full-service interface presented here, logically related functions occupy one layer and offer specific services to the next higher layer. Isolating functions in different layers allows for more reliable development and maintenance

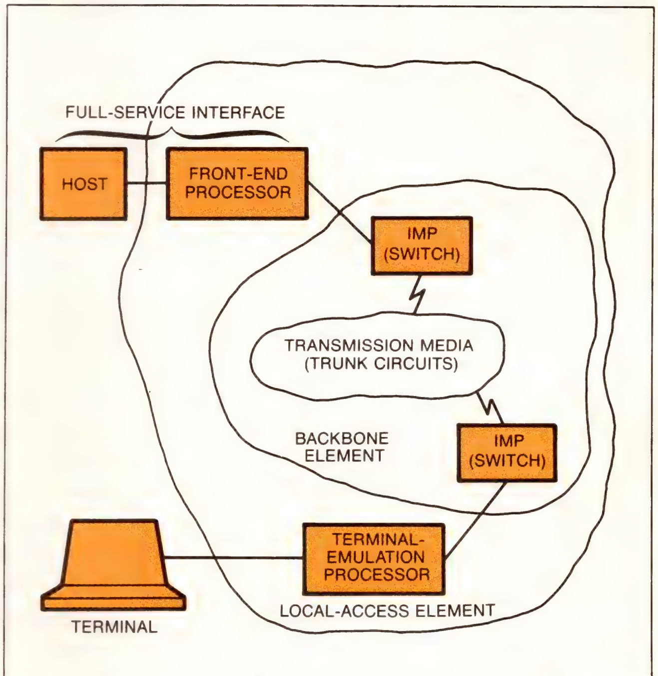



***Fig 1—This diagram of the DDN topology shows the backbone element*** *accessible by the subscriber equipment via the local-access element.*

*In a modular design approach, it's helpful for logically related functions to occupy one layer and offer specific services to the next higher layer.*

and also allows you to respond quickly to rapidly changing requirements in today's networks.

**DDN uses packet-switching technology**

The DDN is the DoD's packet-switching data-communications network and evolved directly from Arpanet (see **box,** "DDN uses packet-switching technology" on pg 152). Intended to be the DoD's primary wide-area network for nontactical applications, it is suitable for all intersite classified and unclassified data communications and consists of two network segments: a backbone element and a local-access element **(Fig 1).**

These two elements provide the commmunications capability necessary for computer systems and terminals from different vendors to share information and other automated data-processing resources. The backbone element contains the packet-switching equipment (nodes) that connects via communications circuits (satellite and terrestrial trunk lines). These nodes, or interface message processors (IMPs), are BBN C/30 minicomputers. Some of the ports of the IMPs allow the subscriber equipment to gain access to the backbone of the network. These ports in turn provide connections to the local-access element, which actually permits the subscriber's data to travel along the backbone.

The Defense Communications Agency (DCA) has operational responsibility for and control of the DDN and has defined a set of standard specifications for

## DDN protocols correspond to OSI standards

Understanding the DDN protocols' relationship to the International Standards Organization (ISO) Open System Interconnect (OSI) protocols, as well as grasping how these layers overlap and perform similar functions **(Fig A),** will aid your comprehension of the concepts described in the accompanying article.

The OSI set of protocols has seven layers:

- The Physical Layer provides the mechanical, electrical, and hardware facilities for transmitting raw data over the physical communications medium.
- The Data Link Layer provides the functional and procedural means of transferring data between the subscriber equipment and a node on the network.
- The Network Layer controls how the units of information are exchanged and routed in the network backbone.
- The Transport Layer performs message fragmentation and reassembly and ensures that messages are routed reliably.
- The Session Layer provides the mechanism for organizing, synchronizing, and managing interactions between hosts or applications.
- The Presentation Layer provides data formats, codes, and representations in a way that preserves meaning while resolving syntax differences.
- The Application Layer doesn't provide services to any other layer and is primarily concerned with the semantics of the application.

| OSI ISO MODEL | DDN | COMMENTS |
|---|---|---|
| APPLICATIONS (LAYER 7) | TELNET, SMTP, FTP | RESIDES ON HOST. UPPER-LEVEL PROTOCOLS (VIRTUAL TERMINAL EMULATION, SIMPLE MAIL TRANSFER, FILE TRANSFER) |
| PRESENTATION (LAYER 6) | | |
| SESSION (LAYER 5) | | |
| TRANSPORT (LAYER 4) | TCP/IP SUITE | TCP SUPPLIES CONNECTION MANAGEMENT. IP SUPPLIES INTERNET ADDRESSES. X.25 PROVIDES DATA TRANSFER ACROSS BACKBONE. |
| NETWORK (LAYER 3) | X.25 (LEVEL 3) | |
| DATA LINK (LAYER 2) | LAP-B | FRAME-LEVEL PROCEDURES (DCE/DTE) |
| PHYSICAL (LAYER 1) | RS-449 OR -232C | MECHANICAL AND ELECTRICAL PROCEDURES |

*Fig A—**As you can see from this table of OSI and DDN protocols,** the DDN layers take into account all seven layers of the ISO OSI model.*

subscriber equipment to achieve compatibility. A subscriber must use one of three basic protocols to establish communications with a remote host:

- Simple Mail Transfer Protocol (SMTP) supports reliable and efficient transfer of electronic mail **(Ref 1).**
- File Transfer Protocol (FTP) enables file transfers between computer systems **(Ref 2).**
- Telnet allows characteristics of different terminals to be mapped into characteristics of a common virtual terminal. This mapping permits a user at a terminal to log in and control an application program on a remote host **(Ref 3).**

Each of these is known as an upper-level protocol and must interface with the DoD standard Transmission Control Protocol/Internet Protocol (TCP/IP) **(Ref 4).** An X.25 (level 3) network-access protocol establishes communications through the backbone **(Ref 5),** and the TCP/IP maintains reliable end-to-end communications. **Fig 2** shows a model of the DoD's hierarchy of DDN protocols.

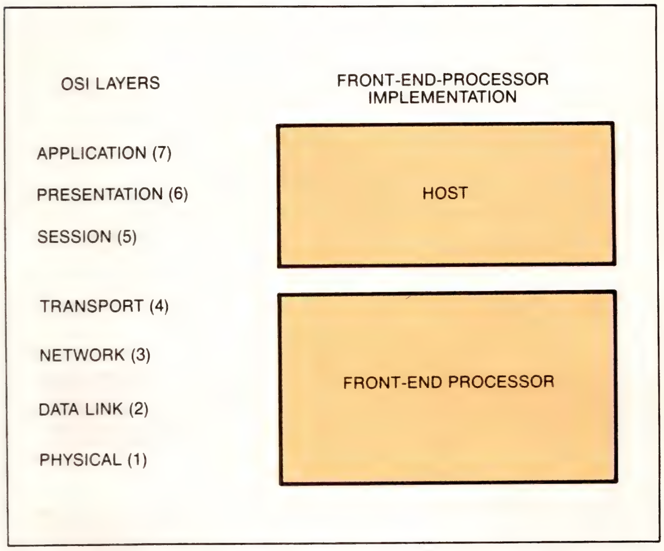



***Fig 3—A front-end processor (FEP) implementation*** *gives the host added processing power for user applications. In this scheme, the FEP performs all communication-related tasks (layers 1, 2, 3, and 4 of the OSI model).*

## An FEP implementation is advantageous

When designing a full-service interface, a front-end processor (FEP) implementation **(Fig 3)** provides advantages because communication-related tasks are delegated to the FEP. In such an implementation, you free up the host, allowing it more processing power for user-application programs.

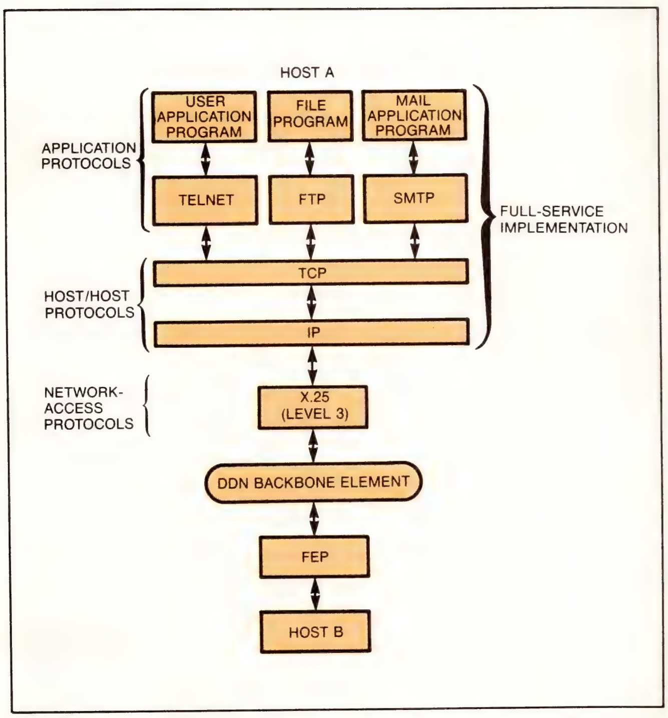



***Fig 2—In this architectural model of the DoD's specifications*** *for DDN protocols, a hierarchy of functions is evident.*

The actual design approach requires the integration of three major components: the hardware circuitry required for interfacing a host to an IMP on the DDN; the software modules residing in the hardware to implement the TCP, the IP, and the network-access (X.25) protocol; and the software modules in the host to implement the upper-level protocols mentioned earlier.

## Interface hardware has three roles

The DDN-interface hardware provides the circuitry and physical connections necessary to connect a host to a C/30 IMP. The hardware performs three major functions: It provides a bus interface from the host to the FEP via a communications CPU and buffer memory; it provides a configurable serial communications channel; and it provides the physical electrical connections to the DDN **(Fig 4).**

Communication between the FEP and the host uses shared RAM located on the DDN-interface hardware. During an initialization phase, the host downloads the executable communications-protocol software and a real-time operating system. A message buffer area stores the data to be communicated over the DDN. You transfer data to and from the host under direct memory access (DMA) control, releasing the host CPU from

*In such an implementation, you free up the host, allowing it more processing power for user-application programs.*

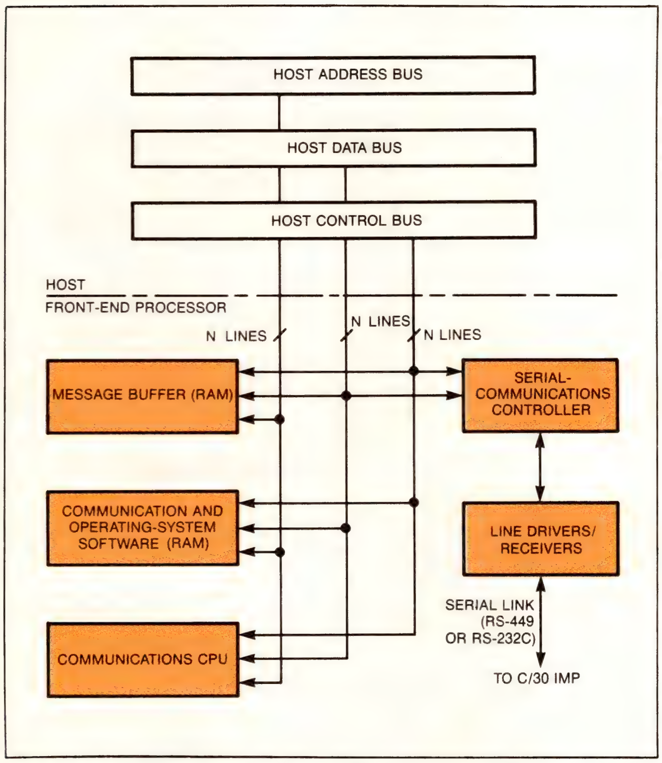



*Fig 4—**This functional block diagram shows the hardware** required for a front-end processor (FEP) to function as a Defense Data Network (DDN) interface.*

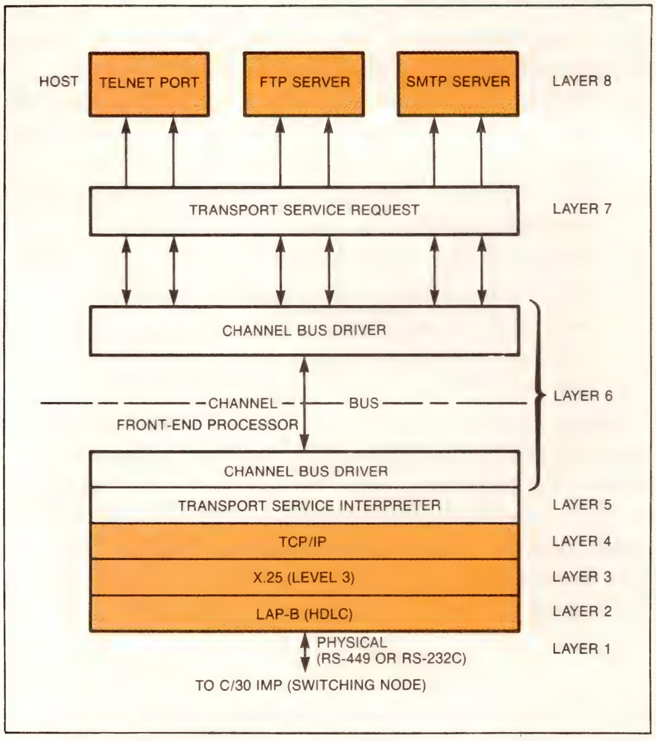



*Fig 5—**This architectural model divides the software modules into independent layers** to implement a modular interface. Layers 2 through 4 are lower-level protocols, and layer 8 contains the higher-level protocols.*

communications overhead. The communications CPU must interpret the high-level commands from the host and provide buffer management and DMA, and it must more or less relieve the host CPU of most of the tasks associated with accessing the DDN.

A programmable serial-communications controller provides the functional and procedural means of transferring the data between the subscriber equipment and an IMP located on the DDN backbone. The DDN requires that data transmission over this link comply with LAP-B (link access protocol balanced), which is a high-level data-link control (HDLC) type of protocol. The controller chip must include the hardware necessary to conform with the LAP-B protocol and be able to handle various programmable baud rates.

The third function the hardware must provide is a physical electrical connection to the DDN. Data transmission between the hardware interface and a C/30 switching node is via line drivers and receivers. This function conforms to either the RS-232C or RS-449 standard and is selectable in the hardware interface.

When it comes to developing the software for a DDN interface, modularity is most important. The modules should be small, yet independent. In **Fig 5**'s 8-layered protocol architecture, each layer represents an independent software module. The host executes the user software and also downloads the network software to the FEP.

Layers 2 through 4 constitute the lower-level protocols (shown in detail in **Fig 6**). Layer 2's data link protocol is specified as LAP-B. You must implement all data transfers between the subscriber equipment and IMPs located on the DDN according to this specification. Specifically, it provides synchronization of data transmission and reception, flow control, and signal detection with error correction. The firmware configures the communications-controller hardware to implement the protocol. You must have any LAP-B implementation fully tested and qualified by the DCA before using it to connect external equipment to the DDN.

The network protocol (layer 3) controls data exchange and routing in the DDN backbone. Currently the DDN supports both X.25 (level 3) and Arpanet (1822) protocols, but eventually the X.25 standard will be the only permitted protocol. You can find the protocol for a DDN backbone connection to an IMP in **Ref 5.** This specifica-

# EDN INFO CARDS

## The Fastest, Most Cost-Effective Way to Generate Sales Leads!


With EDN Info Cards, you can turn a small investment into high-quality sales leads.

Issued six times per year in loose-deck packs, EDN Info Cards are delivered to EDN magazine's U.S. circulation of 121,500 specifiers and buyers. Which means they deliver results! In fact, the average card in a deck pulls literally hundreds of prospects.

You'll enjoy this steady, dependable source of qualified leads for less than 1½¢ per name. And because all inquiries come directly back to you, the faster you respond, the faster you get results.

Used as an adjunct to an advertising/promotion campaign or all by themselves, EDN Info Cards will generate the qualified leads you need to sell your products.

For further information, contact Lauren Fox, EDN Info Cards Manager, at (203) 328-2580.

*Numbers represent actual responses.

*The DDN-interface hardware provides the circuitry and physical connections necessary to connect a host to a C/30 IMP.*

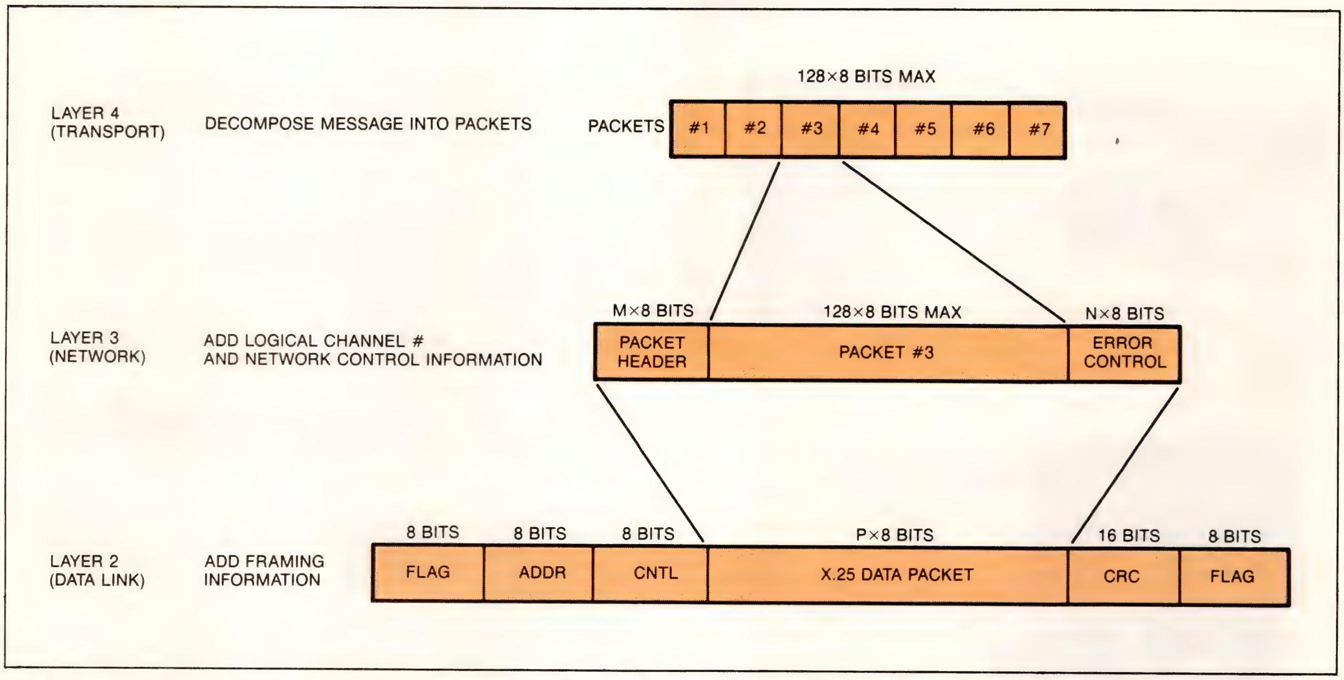



***Fig 6—In this detailed diagram*** *of layers 2, 3, and 4 from* ***Fig 5*** *(the transport, network, and data link protocols), you can see how the protocols nest inside one another.*

tion includes CCITT Recommendation X.25 and FIPS 100/Fed Std 1041, which specifies the general use of X.25-based networks in areas where the X.25 recommendation allows implementation choices. Like LAP-B, any implementation of the X.25 protocol must pass qualification testing before you connect it to the DDN.

In the last of the lower-level protocols (layer 4), the transport protocol consists of the transmission control protocol (TCP) and the internet protocol (IP), which together form a protocol suite.

The IP establishes a datagram service for transmitting packets throughout the network. A datagram is a packet that hops between nodes on the network by traveling statistically multiplexed routes. The IP gives addresses to the packets to identify their source, destination, and message sequence. The destination node collects the packets and checks for security access. MIL-STD 1777 specifies the IP implementation.

## DDN uses packet-switching technology

The Advanced Research Projects Agency Network (Arpanet) was the first large-scale network to link government and university computer systems by using packet-switching technology to transmit data over the network. Arpanet was also the precursor of the Defense Data Network (DDN).

Packet-switching technology dictates that messages to be transmitted within the network are divided into small packets. Each packet is assigned a header to identify its source, destination, and queue position in the message stack.

These packets then travel over the network as independent data packages. When a node in the system receives a packet, it checks the data and corrects errors. The node then either forwards the packet to another node or delivers it to the host to which it is addressed.

A distinctive feature of the DDN is that it routes packets adaptively throughout the network instead of by predetermined paths. Thus, nodes are able to route packets around heavily congested areas of the DDN or areas that have been damaged by line or hardware failure.

# BAYRACK® for Tektronix®

**BAY R&D** custom products are available for TEK®, DIGITAL® and IBM® monitors. Some TEMPEST requirements are also available.


**BAYRACK** is a rugged rackmount adaptor that combines EIA rackmount standards with TEKTRONIX® color graphics terminals.

**BAYRACK** is a simple bolt-on addition which requires no modification to the TEK terminal.

**BAYRACK** provides enhanced performance in demanding industrial applications.

**BAYRACK** can save you time and engineering expense by providing an immediate solution to your industrial color display requirments.

## COLOR GRAPHICS

## FOR INDUSTRIAL APPLICATIONS

**BAY R&D**

P.O. BOX 2517 SANTA BARBARA, CALIFORNIA 93120 U.S.A. (805) 965-4913

*Specifically, the data link protocol provides synchronization of data transmission and reception, flow control, and signal detection with error correction.*

The TCP opens a logical path window in the network for data transfer. It breaks messages into packets for transmission and reassembles received packets into messages. It detects any lost data and provides error checking on an end-to-end basis. Even if individual links in the communications path are destroyed, the TCP establishes and maintains the end-to-end connection in the DDN. MIL-STD 1778 specifies the implementation of this protocol.

The communication processor operating system resides in the FEP (layers 5 and 6) and is a multitasking OS. It performs task scheduling, intertask communications, and message management.

The transport service interpreter (TSI) of layer 5 is a peer-level protocol that interfaces the upper-level protocols in the host to the TCP/IP protocol suite in the FEP. It communicates with its peer in the host, the transport service request (TSR) (layer 7). An interactive primitive defines the command and information exchanges between the two peer-protocol layers. It can be a parameter that describes a function to be performed, or it can be data only.

Information that travels down from the upper-level protocols to the TCP is called a service-request primitive, and information that travels up is called a service-response primitive. When the TSI receives a service-request primitive, it generates the appropriate transport command for the TCP.

**Design includes peer-level protocols**

Layer 6's channel bus driver handles communications between the host's CPU and the FEP's CPU. It permits raw data transfer between the host and the FEP via DMA to the shared memory on the FEP, and it allows the host to pass an initialization procedure to the FEP, which can download the communication processor operating system. The host and the FEP continuously monitor commands and status to facilitate data communications.

The host operating system resides in layer 7 and must coordinate the upper-level protocols with the TSR and the channel bus driver. It must also provide user-interactive software to implement the upper-level protocols (Telnet, FTP, and SMTP). The channel bus driver in the host is the peer-level counterpart of the protocol in the FEP and essentially performs the same tasks.

**TSR of layer 7 is a counterpart, too**

As noted, the TSR of layer 7 is the peer-level protocol for the TCI located in the FEP. It manages the interface between the upper-level protocols and the TCP/IP. In addition to managing data traffic to the FEP hardware and subsequently out to the DDN, the TSR also translates the host's name to a network address for the upper-level protocols.

Finally, you'll remember that the upper-level protocols of layer 8, Telnet, FTP, and SMTP are user-software modules that function as communication tools for anyone who wants to communicate across the DDN. **EDN**

## References


1. *Simple Mail Transfer Protocol (SMTP) Standard,* MIL-STD 1782, Washington, DC, May 10, 1983.
2. *File Transfer Protocol (FTP) Standard,* MIL-STD 1781, Washington, DC, May 10, 1983.
3. *Telnet Protocol Standard,* MIL-STD 1780, Washington, DC, May 10, 1984.
4. *Transmission Control Protocol (TCP) Standard,* MIL-STD 1778, Washington, DC, August 12, 1983.
5. *Defense Data Network X.25 Host Interface Specifications,* BBN, December 1983.

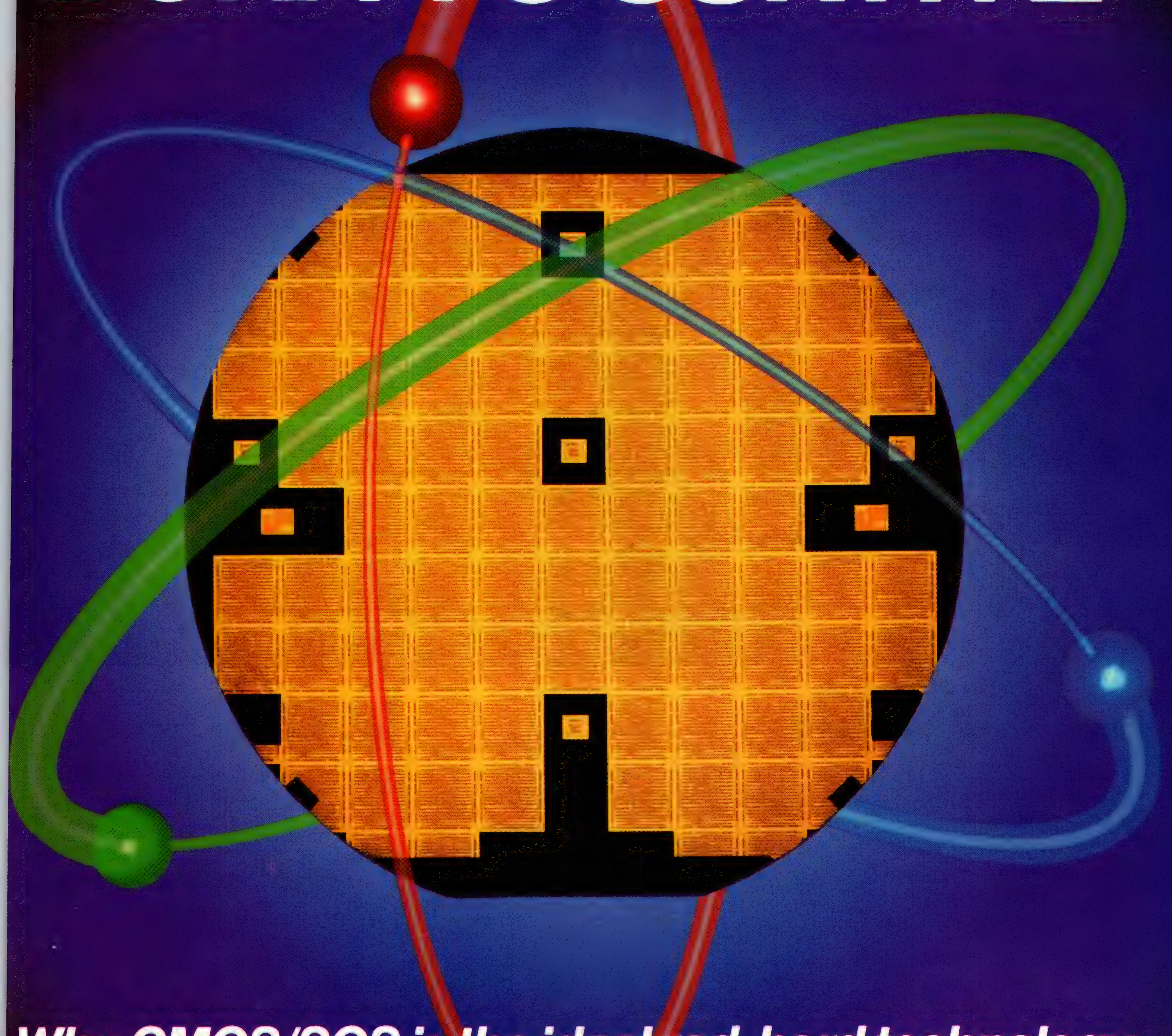

## Author's biography


*Michael E Kubat is a project engineer at Unisys Corp's Defense System Div (Paoli, PA), where he designs data-communication systems. He received a BSEE at the University of Pittsburgh and an MES in Computer Science at Loyola College of Baltimore. In his spare time, Mike enjoys home computing, woodworking, and gardening.*


**Article Interest Quotient (Circle One)**
**High 488 Medium 489 Low 490**

# GE/RCA Silicon-on-Sapphire

# BORN TO SURVIVE

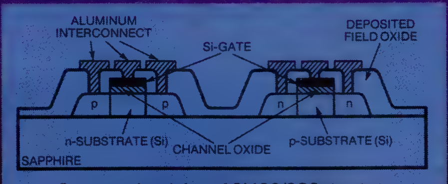


## *Why CMOS/SOS is the ideal rad-hard technology.*

If you're designing aerospace or strategic military systems, CMOS/SOS should be your choice. That's because the sapphire substrate gives you **totally isolated** *n* and *p* devices, for outstanding radiation-hardness.

CMOS/SOS is virtually latch-up free under transient radiation.

It has extremely high tolerance to single event upset (SEU) caused by radiation—for example, SRAMs typically have SEU of $2 \times 10^{-9}$ errors/bit/day. SOS offers a very high total dose tolerance: all the way from 100K Rads to "MEGARAD" dosage.




Cross-sectional view of CMOS/SOS structure showing the sapphire substrate insulating the n- and p-transistors from each other.

When you want SOS performance, there's simply no substitute for GE/RCA. We invented both CMOS and SOS technology. And we have extensive experience in both rad-hard ICs and Class S screening.

*continued* →

# No one offers you a CMOS

## ASICs

Our CMOS/SOS standard cell family withstands total dose radiation of 100K Rads (Si). It can be screened to Class S specifications.

You can choose from dozens of fully-characterized cells, to design ASICs to over 3,000 gates with die sizes up to 100,000 $mils^2$. And use proven, user-friendly design and testing software (our first-time success rate is over 90%).

We offer a variety of packages, including dual in-line, flat packs, leadless chip carriers and pin-grid arrays.

Your CMOS/SOS ASICs will be latch-up free, SEU tolerant, transient upset $>10^{10}$ Rads/second, and give you all the CMOS advantages, including low-power requirements, high noise immunity and wide operating temperature range.

## Logic

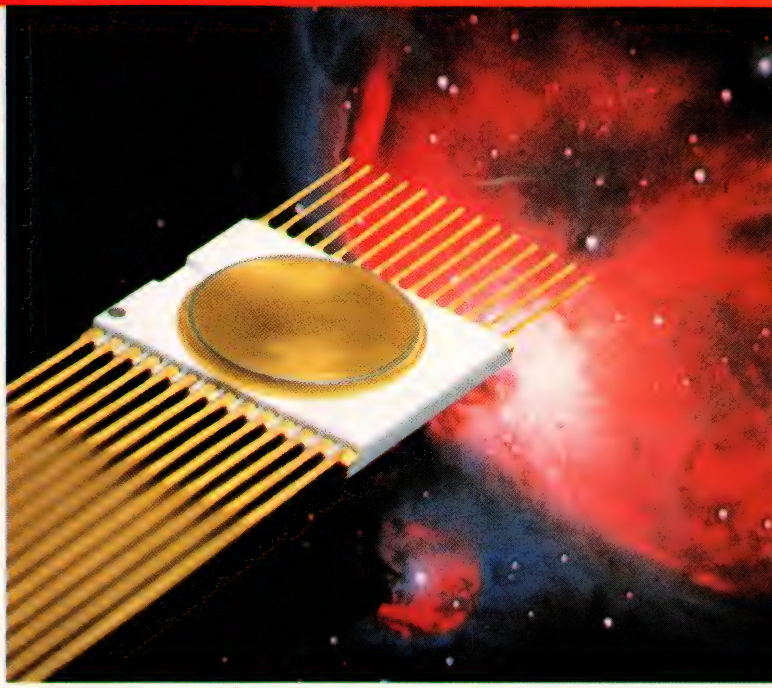
GE/RCA has long been the leader in High-Rel rad-hard logic, with the time-tested CD4000 series, with more than 100 functions, and total dose tolerance of $10^6$ Rads (Si).

Now we've got a new high-speed rad-hard logic series that's an outstanding drop-in, low-power replacement for bipolar LS and ALS circuits. These circuits are as fast as ALS with only a fraction of the quiescent current.

For example, our new HCTS240 octal buffer has a quiescent current of only 5$\mu$A, SEU immunity, latch-up immunity, insensitivity to neutron irradiation, and a transient-upset rate $>10^{10}$ Rads/second. It's available now in volume.

And we'll be introducing many new devices this year, including a 4-bit counter, an octal buffer/line driver, a dual JK flip-flop and a hex inverter.

# broader line of rad-hard products.



## 1750A Processor

When Rockwell needed super-reliable components for their 1750A processor (used in the new small ICBMs), they turned to us.

We responded with ASICs that did the job: the MIL-STD-1750A embedded processor.

The processor has speed >700 KOPS (dias mix). CPU uses six logic chips implemented with our standard cells. And it's in 132-terminal flat packs.

Most important, it meets the critical requirement of rad-hard survivability for strategic weapon systems, the most stringent application that exists. And this processor is available for your programs as well.

## EPIC chip set

This CMOS/SOS Emulating and Programmable IC set can be used to implement new architectures or emulate existing ones, like a 1750A processor.

It consists of an 8-bit-slice processor, controllers, I/O devices and ROMs, giving you complete design versatility.

## 16K RAMs

We're delivering rad-hard 16K static RAMs, screened to Class S, in high volume.

These 16,384 x 1 RAMs are latch-up free; have SEU of $2 \times 10^{-9}$ errors/bit/day; a transient upset rate $>10^{10}$ Rads/second; and total dose tolerance >100K Rads (Si).

Add to this access time of 125 ns (80 ns typical) at 25°C (post-RAD access of 150 ns), and the wide CMOS operating temperature range of -55°C to +125°C, and you can see why we're producing these RAMs as fast as we can.

We also offer 4096x1 and 1024x4 rad-hard SOS CMOS static RAMs, which are being qualified to M38510 Class S.

So if you need rad-hard memories, or any other rad-hard devices, there are only three things you need to remember: CMOS/SOS; GE/RCA—the technological leader; and our toll-free number 800-443-7364, extension 18.

GE RCA

In Europe, call: Brussels, (2) 246-21-11; Paris, (1) 39-46-57-99; London, 0276-685911; Milano, (2) 82-291; Munich, (89) 63813-0.

CIRCLE NO 73

HP's new logic analyzer family gives you more of what you want in logic analyzers. For less.

So now measurements are easier to make. And high-quality HP logic analyzers are easier to buy!

You get the performance that best suits you: from 32 to 400 channels of 100 MHz transitional timing/25 MHz state, and up to 80 channels of 1 GHz timing analysis.

Our new family also offers you easy operation, powerful triggering, a CAE link, an oscilloscope, pattern generation, portability, built-in mass storage, simple probing, optional 3-year protection, and much more.

## The small secret behind the big value.

To give you more for your money, HP developed a Logic-Analyzer-on-a-Chip containing a complete state analyzer, timing analyzer, and acquisition memory. This proprietary HP IC makes exceptional value possible...80 channels of 100 MHz transitional timing for only $7,800*.

You can assign state or timing in 16-channel increments. Get fully independent state, timing, state/timing, or state/state setups. Even time-correlate measurements on complex multiprocessor systems.

## Operational simplicity runs in the family.

We've made our controls even easier than before, without sacrificing performance.

You can make timing or state measurements using just three menus, so you never get lost. Triggering setups, from the simple to the complex, are a snap. And autoscale gives you one-button setup for timing analysis.

You even get a color touch-screen and knob, or optional mouse with the new HP 16500A. Color lets you quickly distinguish between menu choices, measurements, and results...and find glitches more easily.

## Probing made easy.

HP's new passive probes are lightweight and flexible...specially designed to grip easily and securely to your device under test. Plus, our preprocessors give you quick setups with most popular 8, 16, and 32-bit $\mu$Ps, including the Motorola 68020 and Intel 80386. And if you've already invested in HP preprocessors, we offer you an easy upgrade path.

## HP 1651A: full-featured logic analyzer for only $3,900.*

With 32 channels of 100 MHz transitional timing for just $3,900*, the HP 1651A gives the hardware engineer a highly economical, yet powerful debugging tool.

It's a full-featured logic analyzer with no compromises in state and timing capabilities (25 MHz state/100 MHz transitional timing on all channels), memory depth, triggering, or I/O features. It supports most popular 8-bit $\mu$Ps with full inverse assembly. Plus it's compact, weighs just 22 lbs., and has an optional carrying case for easy transport.

## HP 1650A: the new standard in general-purpose logic analysis for just $7,800.*

The HP 1650A features time-correlated state/state or timing/state operation on 80 channels. Plus eight sequence levels to meet your toughest triggering tasks. Yet it's priced below $8,000!

You get 25 MHz state/100 MHz transitional timing on all 80 channels, and preprocessor support for 8, 16, and 32-bit $\mu$Ps. And, the

# More value.

HP 1650A is portable, lightweight, and small enough to fit comfortably on a crowded workbench. It's also programmable, has a built-in disc drive for storing measurements, and provides hardcopy documentation.

## Now, bring real-world measurements into the CAE environment.

The HP 16500A is part of HP DesignCenter...a product development environment that unites engineers from IC design/verification to PCB design and test. By linking the HP 16500A with HP CAE, you can compare measurement results and simulated data on your workstation, and use measurement results as your simulator patterns.


## HP 16500A: modular system solution, priced your way.

The HP 16500A is modular, with the flexibility to meet your debug, characterization, or pass/fail test application needs today and tomorrow. You get a combination of state, timing, oscilloscope, and stimulus-response capabilities through your choice of performance modules. You can have up to 400 channels of 25 MHz state/100 MHz transitional timing. 8 channels of full-featured, simultaneous scope analysis. 80 channels of 1 GHz timing. Or 204 channels of 50 Mbit/sec stimulus.

Just $12,400* buys you a basic configuration with 80 channels of 25 MHz state/100 MHz transitional timing.

You can trigger one module with another. Time-correlate measurements between modules...400 Ms/sec scope and 1 GHz timing, for example. Even view state, timing, and analog on the same screen! Fully programmable, the HP 16500A eliminates the need for separate data storage and printer control. HP-IB and RS-232 are standard.

## Mail the card today!

For more information, fill out and mail the postage-paid reply card today. Call us direct at **1-800-752-0900.** Or contact your local HP sales office listed in the telephone directory white pages. Ask for the electronic instruments department.

**HEWLETT PACKARD**

# Excellent reliability, service, and support.

When you purchase a logic analyzer from HP, you get high reliability. The support you need to be productive with your instrument quickly. And a worldwide sales and service network to ensure your continuing satisfaction for years to come.


## HP 1651A $3,900 *

The HP 1651A is a general-purpose, low-cost 32 channel logic analyzer with many features normally found on more expensive analyzers.

- 100 MHz transitional timing on all 32 channels.
- 25 MHz state on all channels.
- Support for most popular 8-bit $\mu$Ps.
- Fully programmable, with built-in disc drive and hardcopy output.
- Portable and compact — weighs just 22 lbs.
- Optional 3-year protection.

## HP 1650A $7,800 *

The HP 1650A is a general-purpose logic analyzer with a range of features to satisfy many requirements in design and test.

- 100 MHz transitional timing/25 MHz state on all 80 channels.
- Support for most popular 8, 16, and 32-bit $\mu$Ps.
- Configurable as 2 totally independent analyzers.
- Fully programmable, with built-in disc drive and hardcopy output.
- Eight sequence levels with storage qualification, pattern and range recognizers.
- Glitch capture on all channels.
- Optional 3-year protection.

## HP 16500A

The HP 16500A is a modular, configurable system solution that can meet a wide variety of logic analysis, oscilloscope, and stimulus-response measurement requirements.

- Configurable through your choice of performance modules:
  - 25 MHz state/100 MHz transitional timing (80 channels per module) $5,200 *
  - 400 Ms/sec 100 MHz bandwidth digitizing oscilloscope (2 channels per module) $5,500 *
  - 1 GHz timing (16 channel master) $7,800 *
  - 50 Mbits/sec pattern generation (12/48 channels per module) $3,700/$4,000 *
  - Mainframe $7,200 *
- Color touchscreen and knob, with optional mouse.
- Intermodule triggering.
- Two built-in disc drives.
- Fully programmable, with RS-232 and HP-IB interfaces.
- Optional 3-year protection.

* U.S. list price.



HEWLETT PACKARD

E115620
5954-2660


# DC/DC converter can operate through nuclear blasts

*With an off-the-shelf, radiation-hardened dc/dc converter, you can design a power system that could operate continuously even if subjected to the transient radiation of a nuclear explosion.*

Elaine P Bondos and Larry L Longden,
*IRT Corp*

Two basic levels of radiation hardness exist for power supplies. The first merely requires a supply to survive the radiation of a nuclear blast. The term "survive" means that the power supply does not have to be functional during and immediately following exposure to the nuclear radiation. However, the power supply must perform up to its specifications after the transient radiation effects have dissipated.

The second level of hardness pertains to systems that can't tolerate power outages. Such systems' power supplies must not only survive the radiation, but must also provide power during and immediately following the explosion. This second level of hardness is normally referred to as an "operate-through" power requirement. In this case, the hardening requirements are much more stringent, so such supplies are harder for you to design.

Consequently, you can group the applications for a general-purpose radiation-hardened dc/dc converter such as the HPS-3015 (see **box,** "Hardened dc/dc con-

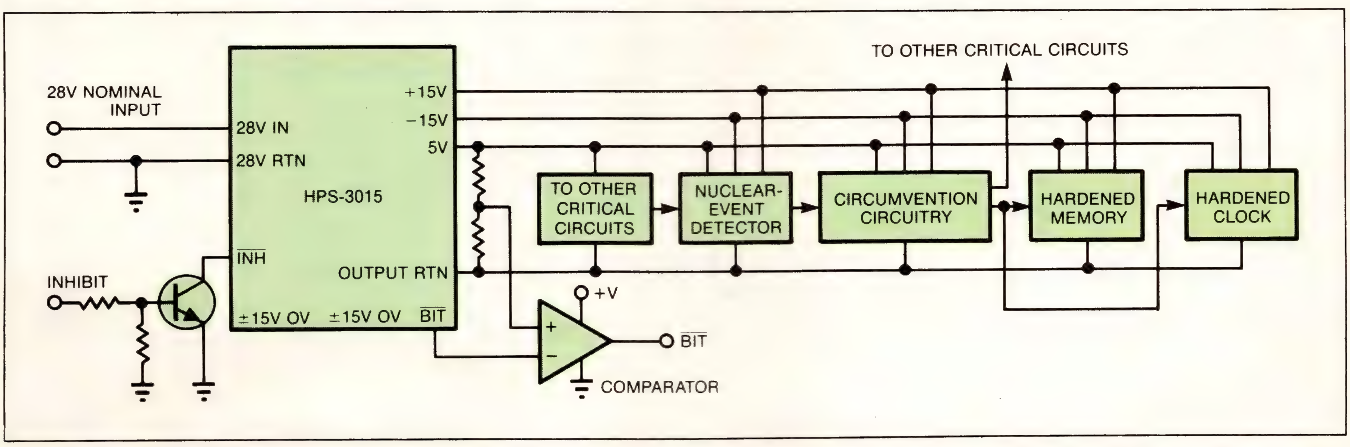



***Fig 1—In this configuration, the converter*** *provides operate-through power. The output of the converter goes only to critical circuitry.*

*Applying the HPS-3015 dc/dc converter in an operate-through power supply is simple if you have a source of continuous input power for the converter.*

verter speeds design") into these two categories, depending on which type of power supply you create with it.

The application of the HPS-3015 dc/dc converter in an operate-through power supply is simple if you have a source of continuous input power for the dc/dc converter. The output of the converter goes only to critical circuitry such as a nuclear-event detector, so-called power-circumvention circuitry, a hardened memory, and a hardened clock. **Fig 1** gives an example of how the HPS-3015 can power such critical circuitry. The figure shows interfaces for the converter's inhibit input and the built-in-test (BIT) output.

A more general-purpose application for the converter is to use it to provide small amounts of power to hardened systems. In this application, the converter is not required to operate through a nuclear explosion. However, the HPS-3015 is still required to survive exposure to both gamma rays and neutrons. Then, after the detonation, the converter must provide power while still meeting its electrical specifications. For this application, you connect the HPS-3015 similarly to the way it's connected in **Fig 1**, with the exception that the input power source does not need to be continuous during the irradiation.

**Fig 2** shows the converter's use in what's often referred to as a "power-circumvention" application. In this application, the converter drives electronic devices that are sensitive to burnout caused by gamma-radiation-induced latch-up.

To prevent burnout and bring the devices out of latch-up, you must remove the power to the circuitry quickly—usually in less than 10 μsec. Adding crowbar circuits to each of the power supply's outputs accomplishes this quick removal. Power crowbars are high-power shunts capable of discharging the power supply's filter capacitors in a short period of time without being damaged. The HPS-3015 can withstand having its outputs shorted to ground.

**Some basics on radiation hardening**

Rigorous policies and regulations such as those of the Department of Defense **(Ref 1)** have led to an increase over the past few years in the number of military systems having radiation-hardening and survivability requirements. Besides designing with radiation-hardened devices such as the HPS-3015, military-system designers also need to understand the effects of radiation on electronic devices and become familiar with the basic design techniques of the emerging discipline of radiation hardening.

Shock, blast, and heat are not the greatest threats that a nuclear explosion poses to electronic devices. At a point several miles from ground zero, the most dangerous threats are, instead, the electromagnetic pulse (EMP) and the radiation pulse. These effects are the most dangerous because they cause performance degradation, latch-up, and burnout of electronic devices.

Radiation from a nuclear explosion is transitory, but its effects are both transient and permanent in nature. Radiation not only disrupts the operation of the system, but also degrades the system's overall performance and, in the worst case, produces functional failure. For

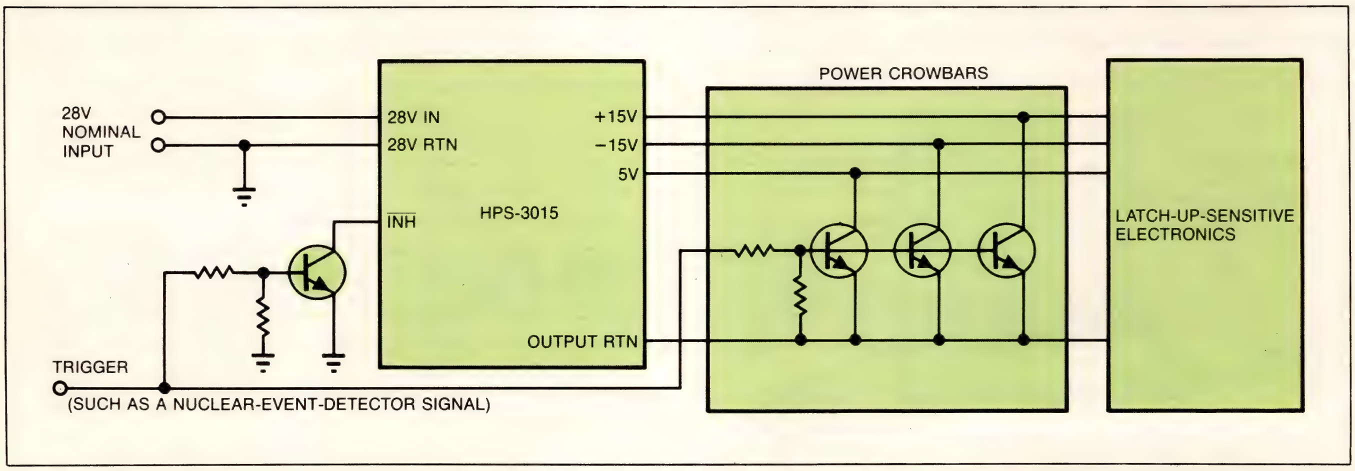



***Fig 2—In a so-called power-circumvention application,*** *the converter drives electronics that are sensitive to burnout caused by gamma-radiation-induced latch-up. Crowbar circuits added to each of the power supply's outputs can discharge the power supply's filter capacitors quickly. The HPS-3015 can withstand having its outputs shorted to ground.*

electronic devices, the primary transient radiations of concern are gamma-radiation dose rate, total gamma-radiation dose, and neutron flux.

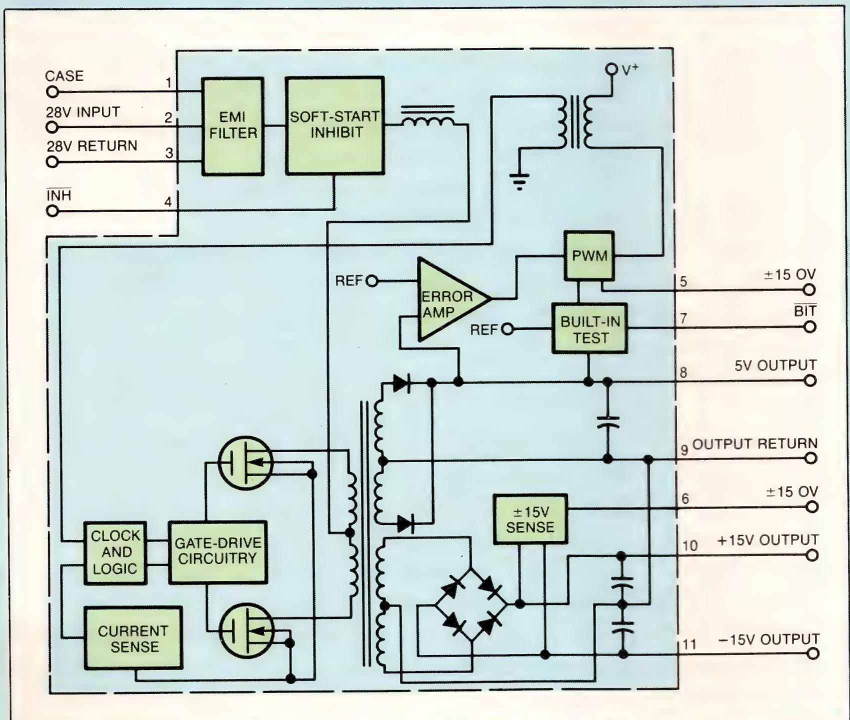
The gamma-radiation dose rate (gamma radiation is a type of ionizing radiation) is the rate at which energy is deposited in semiconductor material over the duration of the radiation. This radiation's dose rate is measured in units of rad(Si)/sec.

Short pulses of ionizing gamma radiation that emanate from a nuclear-weapon detonation create free electron-hole pairs within reverse-biased semiconductor junctions. These electron-hole pairs result in a transient leakage current called photocurrent. The magnitude and duration of the photocurrent depend directly on the amplitude and duration of the radiation and also on the characteristics of the devices being irradiated. At low radiation levels, the effect on the system is functional upset. At high levels of radiation, the transient can be of sufficient magnitude and duration to produce permanent damage and thus functional failure.

In junction-isolated integrated circuits, whose inte-

## Hardened dc/dc converter speeds design

The Model HPS-3015 dc/dc converter (from IRT Corp) is hardened against high radiation levels. It can deliver operate-through power in the presence of gamma-radiation rates as high as $5\times10^{10}$ rad(Si)/sec, and it can survive as much as $1\times10^{12}$ rad(Si)/sec without damage. The converter continues to meet all performance specs after exposure to a neutron flux of $1\times10^{13}$ neutrons/cm$^2$ and a total gamma-radiation accumulation of $1\times10^5$ rad(Si). To certify each converter's operate-through characteristic, the vendor tests each device with simulated ionizing radiation.




*__The HPS-3015 dc/dc converter__ can deliver operate-through power in the presence of gamma-radiation rates as high as $5\times10^{10}$ rad(Si)/sec, and it can survive as much as $1\times10^{12}$ rad(Si)/sec without damage.*

The converter operates from a nominal 28V dc power source as defined in MIL-STD-704D and provides three output voltages, 5V and ±15V. Its total output power is 30W. The HPS-3015 is built following test methods in MIL-STD-883.

The converter has a built-in-test (BIT) output that indicates when the 5V output is within ±10% of the nominal output voltage. An inhibit input, which shuts down the outputs, provides external control. The power-line input has EMI/EMC filtering to meet provisions CE-01 and CE-03 of MIL-STD-461C.

Because the HPS-3015 can be used with external overvoltage crowbars, it can't be damaged by output short circuits. The HPS-3015 doesn't automatically shut down when shorted out; it continues to provide a fixed amount of energy to the outputs. The amount is based on the current-limit setting. The converter resumes normal operation when the short circuit is removed.

*A general-purpose application for the dc/dc converter is to use it to provide small amounts of power to hardened systems.*

grated devices are separated by reverse-biased junctions and are produced from a common semiconductor substrate, the gamma-radiation response is more complicated. Because of the substrate's additional semiconductor region, integrated circuits are also susceptible to a condition called latch-up. Latch-up behavior is similar to the On condition of a silicon-controlled rectifier (SCR), and it occurs across the IC's 4-layer, pnpn structure. The transient photocurrent initiates latch-up and persists until power is removed or burnout occurs.

**Radiation causes permanent degradation**

Neutron flux (defined in units of neutrons/cm$^2$) produces damage in semiconductor material by collisions of the neutrons with the atoms in the crystalline structure of a semiconductor device. The neutrons displace crystal atoms from their lattice sites. This displacement generates defects which, in turn, cause a decrease in the semiconductor's minority-carrier lifetime.

Bipolar devices, therefore, whose responses are highly dependent on the minority-carrier lifetime, can exhibit severe performance degradation when subjected to radiation. These performance degradations include such conditions as reduction in gain and increase in leakage current and junction voltage.

MOS devices, on the other hand, are majority-carrier devices; they're not nearly as sensitive to neutrons as bipolar devices are. The primary effect of neutron flux on MOS devices is that of increasing the semiconductor's resistivity.

The total gamma-radiation dose is the accumulation of ionizing radiation from all sources and is measured in units of rad(Si). The primary damage mechanism from the total gamma dose is an increase in surface leakage and the buildup of trapped charge within oxide layers. In bipolar devices, these effects cause permanent degradation similar to that caused by neutrons.

Because of their sensitivity to charge, MOS devices are vulnerable to the charge buildup caused by exposure to gamma rays. The primary effect on MOS devices is a shift in gate-threshold voltage, which demands larger and larger bipolar gate-drive voltages to ensure proper operation. This shift worsens with additional gamma dosage until functional failure occurs.

In general, radiation-hardened electronics are more complex, require more power, and are larger than their nonhardened counterparts. The HPS-3015, for instance, uses a current-fed topology, so it can survive a high gamma-dose rate. A current-fed design is an effective way to ensure the survival of power supplies during high gamma-dose radiation because of the inherent current limiting provided by the supply's input inductor.

However, the current-fed topology introduces a design tradeoff. Current-fed converters typically have poor cross-regulation specs. The HPS-3015 would be no exception if not for the fact that it contains some additional circuitry, which improves regulation.

The converter has an additional overvoltage-protection scheme on its ±15V outputs. You select this feature by connecting the device's two ±15V OV pins to each other. The overvoltage-protection scheme overrides the normal regulation loop. Thus, when the 5V output is heavily loaded and the others are not, the ±15V overvoltage protection will keep the ±15V outputs at their maximum level while decreasing the 5V output voltage slightly. Meanwhile, to be able to operate at a high switching frequency, the HPS-3015 incorporates power n-channel MOSFETs as its 125-kHz switching elements.

MOSFETs, however, are extremely sensitive to the total gamma dose. These n-channel devices are normally turned on by applying positive gate-to-source voltage and turned off by applying zero gate-to-source voltage. Exposure to gamma radiation causes the gate-to-source threshold to decrease and eventually to go negative. Therefore, the converter must generate negative bias from its positive input power if the MOSFETs are to turn off after radiation exposure.

Generating negative bias during normal operation is not a problem. However, the need for negative bias during start-up and while the converter is inhibited requires that there be a switch in series with the input power line. Therefore, the negative bias circuit gets its power directly from the supply's input. In addition, until negative gate drive develops, you can't apply power to the power-switching elements (the drains of the MOSFETS via the input inductor and transformer). This withholding of power ensures positive control of the MOSFETs and prevents the input inductor from saturating and burning out the MOSFETs.

In order for the converter to meet the operate-through requirement, the response of the control circuitry to gamma rays must not only be controlled, but the magnitude and duration of any aberrant circuit operation must be minimized. Controlling the output upset is more difficult in a hybrid than in a conventional supply. Designers of conventional supplies usually meet the supplies' operate-through power specs by increasing the amount of energy storage within the circuit.


# New Kepco/TDK 150KHz Switching Power Supply, SERIES RBX

This brand new product of advanced Kepco/TDK technology squeezes more power into less space than you'll find most anywhere else. It's a highly efficient, FET-based, fast-responding switcher operating at 150KHz.

The Kepco/TDK Series RBX gives you remote on/off, remote voltage control, remote error sensing, overvoltage and undervoltage protection, rectangular current limiting, an "output OK" LED, selectable 115/230V input, and a current balance circuit which lets you parallel up to three units and have them share the load.

| Model | RBX 02-120K | RBX 05-120K | RBX 12-50K | RBX 24-25K | RBX 48-12.5K |
|---|---|---|---|---|---|
| Volts | 2V | 5V | 12V | 24V | 48V |
| Adjustment | 1.6-2.2V | 4.0-5.5V | 9.6-13.2V | 19.0-26.5V | 38.4-52.8V |
| Amps | 0-120A | 0-120A | 0-50A | 0-25A | 0-12.5A |
| OVP | 2.6-2.8V | 6.0-6.5V | 14-14.5V | 27-27.5V | 55-57V |
| Current limit | 125-145A | 125-145A | 52-60A | 26-30A | 13-15A |
| Efficiency | 65% | 80% | 80% | 85% | 85% |
| Dimensions | 3$\frac{3}{4}$" x 7$\frac{7}{8}$" x 8$\frac{11}{16}$" plus $\frac{3}{4}$" for connectors | | | | |
| Safety | UL478, CSA C22.2-154 | | | | |
| Prices | $675 (OEM quantity discounts available) | | | | |

KEPCO® THE POWER SUPPLIER™

For complete specifications and literature, call or write
Dept. JSF-12. KEPCO, INC., 131-38 Sanford Avenue, Flushing, NY 11352 USA • (718) 461-7000
TWX #710-582-2631 • FAX (718) 767-1102

CIRCLE NO 72

They increase the amount of energy storage by adding output-filter capacitance and increasing the flux capacity of the magnetics.

These design alternatives are not available in a small hybrid design because the filter capacitors and magnetics are by far the largest components in the converter. With this conventional path blocked, the response of each component could significantly affect the supply's output response. Therefore, the converter's control circuitry uses bipolar devices because they are well characterized and typically have the shortest upset time. Further, to meet the survival specifications at the maximum gamma-dose rate, the HPS-3015's semiconductors have current-limiting series resistors.

To keep the number of control signals to a minimum, the converter's pulse-width modulator is on the secondary side and the clock and control circuitry are on the primary side of the transformer. In isolated power supplies, optical isolators normally couple control signals between the primary and secondary sides. This approach is not practical in a radiation-hardened power supply because both gamma rays and neutron radiation severely degrade the gain of optical isolators. This converter uses a transformer for feedback. **EDN**

## Reference

1. DoD Instruction 4245.4, *Acquisition of Nuclear-Survivable Systems*, September 2, 1983.

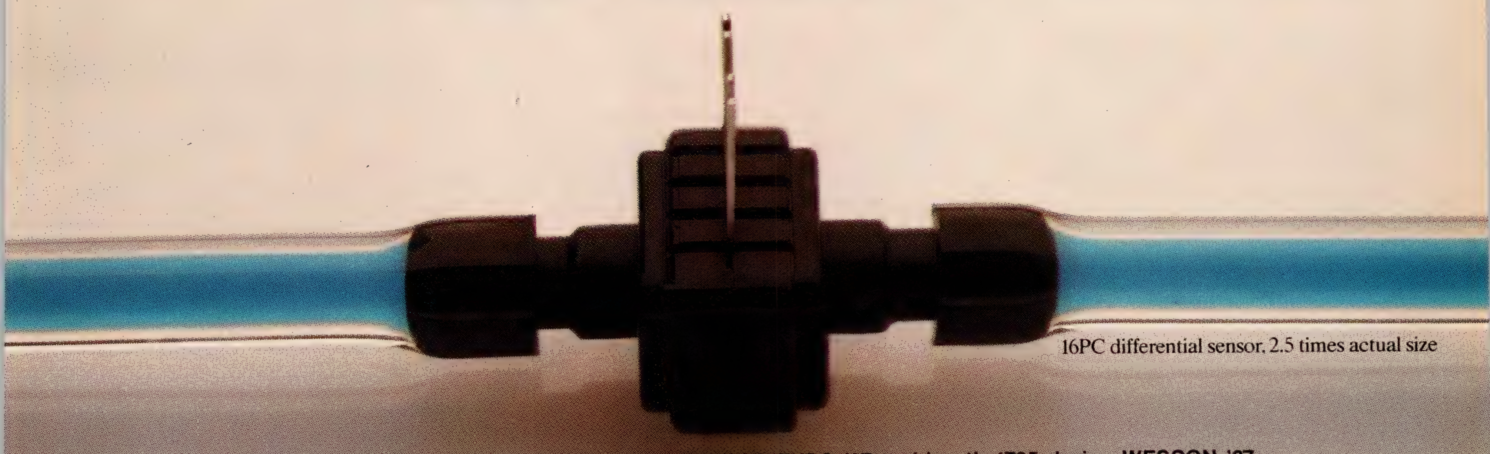
## Authors' biographies

*Elaine Bondos is a product manager in IRT Corp's Survivability Products Div (San Diego, CA). She earned a degree in applied physics from the University of California at San Diego and is currently pursuing an MBA in marketing at San Diego State University. Her leisure pursuits include racquetball, swimming, and sailing.*

*Larry Longden is a division manager and manager of product development in the Survivability Products Div of IRT Corp. Larry, who has been with the company for 13 years, holds a BSEE and an MSEE from San Diego State University. He is a member of the IEEE. In his spare time, he enjoys racquetball, personal computing, and automobiles.*

Article Interest Quotient (Circle One)
High 479 Medium 480 Low 481

# How to sense liquid pressure without getting soaked.



16PC differential sensor, 2.5 times actual size

**Stop by and visit us in booth 425 during SENSOR EXPO '87 and booth 1725 during WESCON '87**

At about $15 a sensor, the 16PC is the lowest cost method of sensing the differential pressure of liquids and high-humidity gases.

And while our new miniature sensor is economical, it's also very reliable. Thanks to the unique new chip mounting technique we use. It seals the sensing element so that moist media can be applied to both sides of the sensor chip.

Temperature compensation and on-chip laser trimming add to reliability as well, ensuring high stability over 0-5, 0-15 and 0-30 pressure sensing ranges.

The 16PC Series is compatible with high volume circuit board assembly processes and is available in differential, gage and modular versions.

Applying technology innovatively is just one of the ways we can help you save money. To find out more, call us at 815-235-6600. Or write MICRO SWITCH, Freeport, IL 61032.

**Together, we can find the answers.**

**MICRO SWITCH**
a Honeywell Division

**CIRCLE NO 77**

# 32-bit DSP device breaks the floating-point barrier.

It flies at 13.4 MFLOPS. Roars through instruction cycles at 150ns. Performs with 32-bit floating-point precision. And packs all that processing power onto a single CMOS chip. NEC's μPD77230 Advanced Signal Processor gives you the edge in image processing, graphics workstations, telecom and instrumentation. Because it delivers overpowering advantages in speed and accuracy.

## SPEED IS EVERYTHING

Today's DSP devices work with sum-of-products algorithms that require hundreds of multiplication operations for each sample input. Processing speed makes the decisive difference. And no processor keeps pace with the 77230. It gives you 32-bit full floating-point arithmetic at 13.4 MFLOPS. And executes up to six concurrent operations, including multiply and accumulate, in a 150ns cycle.

| | μPD77230 | 77220 (Fixed-point) | 77C20A | 77C25 |
|---|---|---|---|---|
| CYCLE TIME | 150ns | 150ns max. | 244ns | 122ns |
| ON-CHIP MEMORY | | | | |
| DATA RAM | 1K × 32 | 512 × 24 | 128 × 16 | 256 × 16 |
| PROGRAM ROM | 2K × 32 | 2K × 32 | 512 × 23 | 2K × 24 |
| DATA ROM | 1K × 32 | 1K × 24 | 510 × 13 | 1K × 16 |
| INTERNAL BUS | 32-Bit | 24-Bit | 16-Bit | 16-Bit |
| MULTIPLIER | 32 × 32 | 24 × 24 | 16 × 16 | 16 × 16 |
| PACKAGE | 68 PGA | 68 PLCC, 68 PGA | 28 DIP, 44 PLCC | 28 DIP, 44 PLCC |

## IDEAL PRECISION

With 32-bit floating-point capability, our advanced signal processor eliminates problems with round-off error, quantization noise, scaling, limit cycles and over/underflow. And the 77230 is unique in offering a 55-bit multiplier result (8-bit exponent, 47-bit mantissa). With eight 55-bit registers, 47-bit ALU and barrel shifter.

Find out how NEC's high-speed floating-point processor can help your product break performance barriers and open new market opportunities.


# Hybrid modules help you implement a 1553B interface

*The subsystems of integrated aircraft weapons systems built for the DoD must communicate according to the MIL-STD-1553 protocol. By using standard, off-the-shelf hybrid modules, you can implement an intelligent interface between your 1553 subsystems and host subsystem without hampering the host's performance.*

Daryl C Josephson, *ILC Data Device Corp*

MIL-STD-1553 weapons subsystems that you design must meet both the timing requirements of MIL-STD-1553 and the memory-management requirements associated with multiple-message transfers. These dual requirements can burden the subsystem's host processor and limit the processor's ability to perform useful functions not directly related to 1553 communication.

To be effective, therefore, an interface to the MIL-STD-1553 bus must increase the degree of autonomous operation provided by each module connected to the bus. Such an increase in autonomy permits the system host to concentrate on higher-level tasks while the interface circuitry takes care of communication housekeeping chores.

You can use off-the-shelf hybrid modules such as the BUS-65600 to offload the host of these housekeeping chores. This subsystem module can perform bus-controller (BC), remote-terminal-unit (RTU), and monitor-terminal (MT) functions.

By adding an interface module, the BUS-66300II, you can directly interface the BC/RTU/MT modules to the system host's memory. You then transfer data between that memory and the subsystem modules on a word-by-word basis. The interface hybrid (the 66300II) operates autonomously, offloading the host subsystem of communication housekeeping chores. The modules are available in thick-film, chip-and-wire hybrid construction, as well as in flat packs and single-chip PGAs.

The BUS-65600 data-transfer protocol requires DMA-type handshaking (bus request, bus grant, bus acknowledge) for each transmitted word of data. All transmitted words must be checked for information required by the standard: word type, address, protocol errors, and transmission errors. The BC/RTU/MT module reports errors by generating an interrupt corresponding to each type of error; specific error handling is left up to you.

When the BC/RTU/MT module is operating as an RTU, the terminal provides asynchronous access to status-word bits, auto-illegalization of control codes, and access to status and built-in-test words.

When operating as a bus controller, the module accepts control information such as the type of transfer the host is initiating and the mode of operation desired by the host. The host transmits the control information

*An effective interface to the 1553 bus must increase the degree of autonomous operation provided by each module connected to the bus.*

at the start of each message. The terminal then automatically requests the necessary command and data words relating to the message.

In the monitor-terminal mode of operation, which allows you to capture and examine all 1553 bus traffic, the BC/RTU/MT module appends an identification word to each word transmitted over the 1553 bus. The subsystem host uses the identification word for further transmission analysis.

Although modules such as the 65600 provide BC/RTU/MT terminal functions, they don't support the transfer of multiple messages, or message blocks. In addition, the overhead associated with word-by-word transfers (a DMA-type handshake is initiated for each transfer word) can lead to a situation in which the host is interrupted every 20 μsec. For each of these interrupts, the host must either respond or set the subsystem-busy flag. The subsystem is also charged with implementing its own memory-management scheme.

The interface module, the 66300II, acts an intermediary between the host subsystem and the BC/RTU/MT module. The interface module handles 1553 bus-to-memory I/O timing requirements and memory-management functions associated with message-block transfers **(Fig 1)**.

To effect a data transmission using the interface

## MIL-STD-1553B

The Aircraft Internal Time Division Command/Response Multiplex Data Bus specification set forth in the MIL-STD-1553B document defines a serial communication bus that operates at a data rate of 1M bps. Devices attached to the MIL-STD-1553 serial bus can operate as bus controllers, remote terminal units, or bus monitors. The specification allows data transmission to take place in any of four manners: bus controller to terminal, terminal to terminal, terminal to bus controller, and broadcast.

For example, a bus-controller-to-remote-terminal-unit transmission sequence proceeds as follows: First, the transmitting device sends a command word, which contains a terminal address and also indicates how many data words will follow; then it sends the data words. The receiving device must return a status word to the transmitting device within 4 to 12 μsec **(Fig A)**. This short response time generally precludes real-time software decoding of subaddresses by the μP at the receiving end.

Each 20-bit word transmitted over the bus is one of three types: a command word, data word, or status word, and each type has a different format **(Fig B)**. All three types begin with three synchronization bits; the final bit is a parity bit. In a data word, the remaining 16 bits are used for data; in a command word, they're used for terminal address, subaddress, mode, and data-word count; and in a status word, they hold error and acknowledge information.

MIL-STD-1553 allows for two different approaches to the control of communication flow on the bus. In the stationary-master approach, a single bus controller orchestrates the bus communications for all devices on the bus. In the nonstationary-master approach, control of the

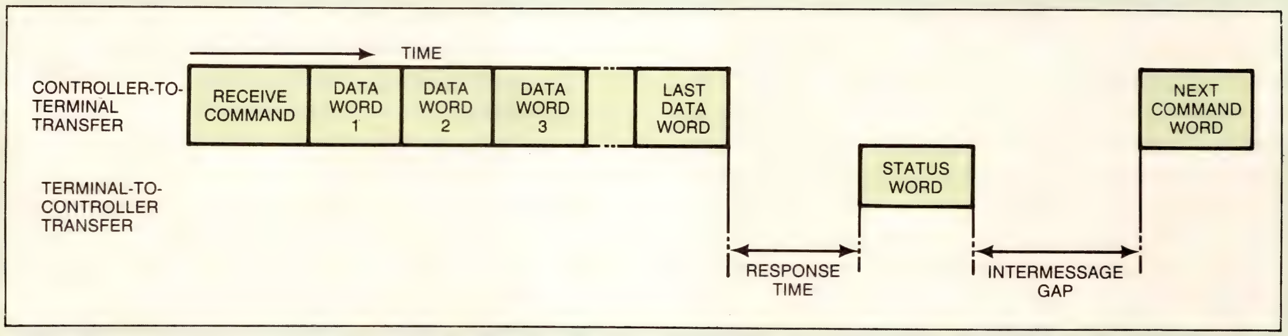



***Fig A—Communications on the 1553 bus take place in blocks of 20-bit words.*** *For a BC-to-RTU transfer, the word sequence always follows the format illustrated here: The communication initiator transmits a command word, followed by a string of data words; the recipient then returns a status word.*

module, the host must deliver control information, 1553 command and data words, and message-level options to memory that it shares with the interface module. The host must also set aside locations in memory for the storage of 1553 status words, built-in-test words, and additional device-specific status information such as format errors and response timeouts. After loading the memory, the host initiates a 1553 transfer by instructing the interface module to start the transfer. The interface module transfers messages on the 1553 bus until it encounters some type of stop condition, such as "no more messages" (in BC mode), "no more data" (in RT mode), or "reset" (in any mode).

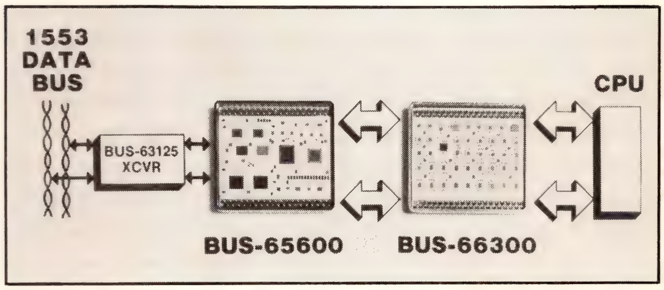



***Fig 1—You can interface your host CPU to the 1553 bus*** *by using a 66300II interface module, a 65600 BC/RTU/MT module, and a transceiver. The 1553 standard allows you to couple the transceiver directly to the 1553 bus, as shown here, or to couple it to the bus by means of a transformer.*

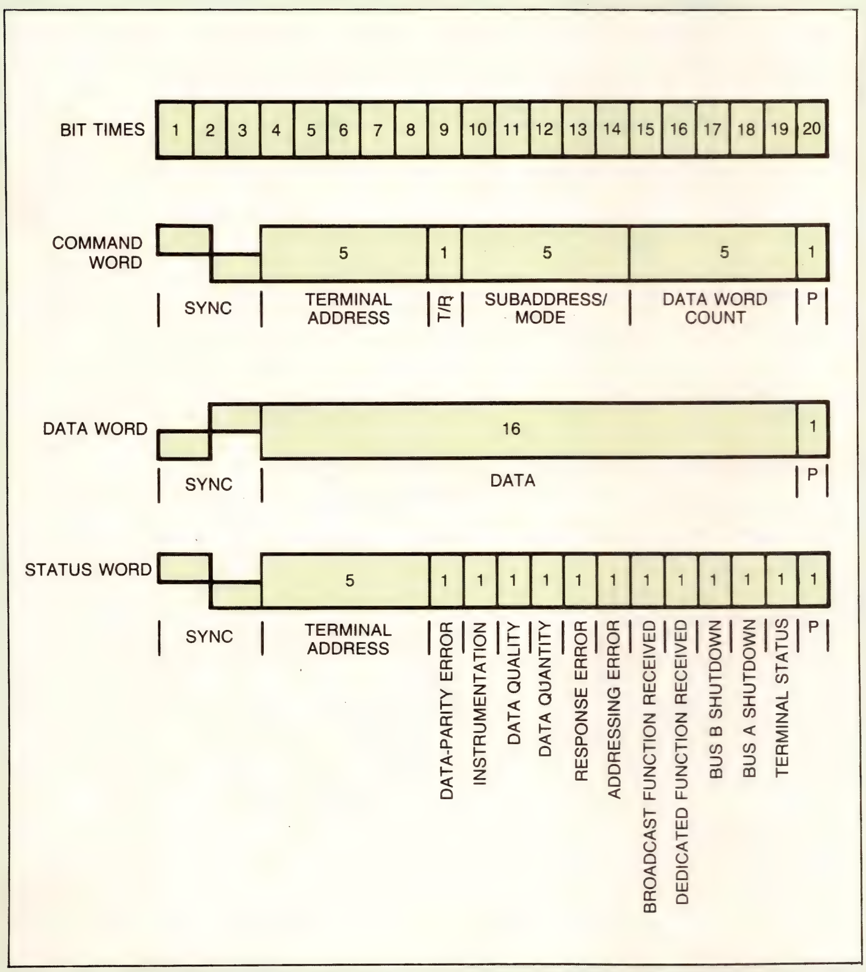



***Fig B—According to the MIL-STD-1553 spec, command, data, and status words*** *are all 20 bits long. The first three bits are synchronization bits; the last bit is a parity bit.*

bus is transferred from an active bus controller to a potential bus controller. MIL-STD-1553 supports both modes of operation.

You can implement a nonstationary master either in round-robin fashion or in polling fashion. In the round-robin approach, a single controller can be bus master only for a certain amount of time; after that time, control passes from master to master. In the polling approach, the current master queries potential masters to determine which of them has the highest priority before surrendering the bus to it. MIL-STD-1553 doesn't specify which of these approaches to use or which method of bus acquisition to use. If you employ the nonstationary-master approach, the timing and ordering of bus acquisition is left up to you.

## Reference

1. Titus, Jon, "MIL-STD-1553 bus finds use in diverse military systems," *EDN*, April 11, 1985, pg 60.

*Memory management is one of the major functions that an interface between the 1553 bus and a μP subsystem must provide.*

The interface module is accessible to the host at any time, so the host can use the interface module's monitor function to monitor the operation of the interface between the subsystem host and the 1553 bus or to examine memory that the host and interface module share. The interface module doesn't provide specific error detection and correction; however, it does provide all the I/O signals necessary to support those functions.

Memory management is one of the major functions that the interface between the 1553 bus and a μP subsystem should perform. The 66300II hybrid employs a dual-sequential memory-management technique. This technique allows two structures, an active and an inactive message-block transfer structure, to exist si-

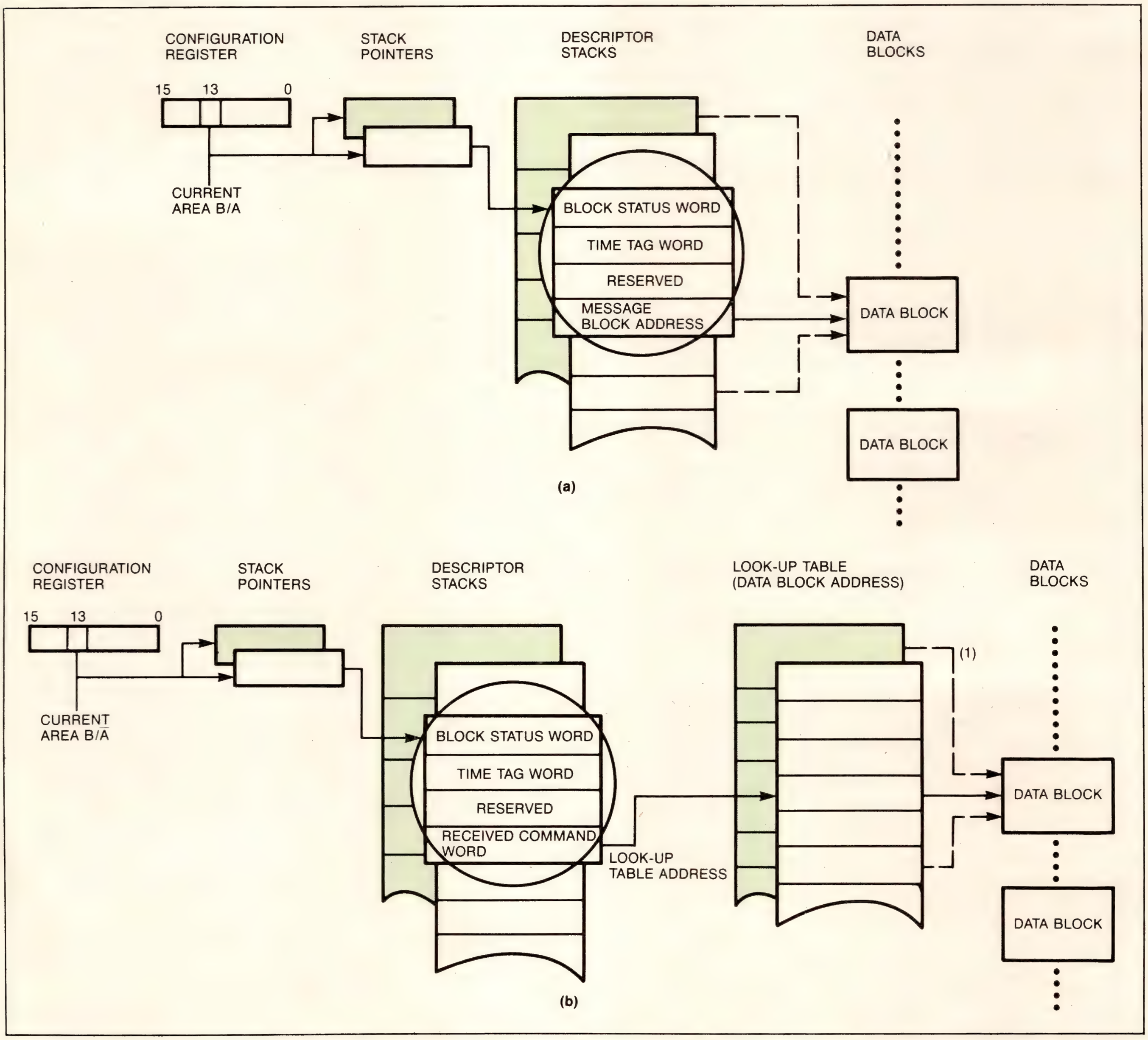



***Fig 2—Although the bus-controller (BC) and remote-terminal-unit (RTU) functions** of the 65600 BC/RTU/MT module are distinctly different, the 66300II interface hybrid stores data in a similar manner for both functions. For the BC function, the interface module organizes memory as shown in **(a)**: The descriptor stack has a pointer directly to the data block. The memory organization for the RTU function **(b)** replaces the fourth word of the descriptor stack with a pointer to the look-up table.*

# HEADACHE #1553


he original cure for 1553 esting headaches was the BMC I. As good as it is, the all-new **DBMC II** is even better. Fairchild design xpertise combined with user feedback has produced the ultimate in Bus Testers.

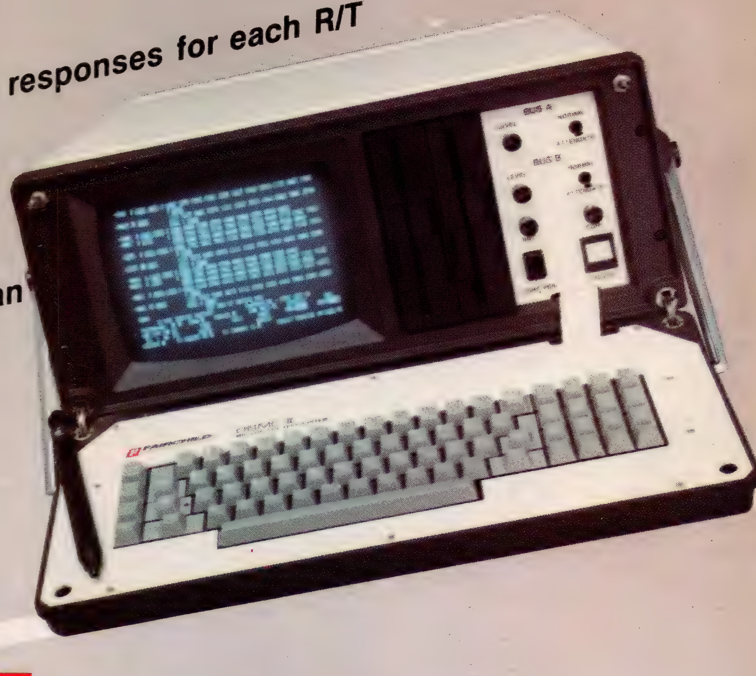
**BMC II** is, believe it or not:

- **Friendlier**
- **Faster**
- **More functional**
- **State-of-the-art bus control**

**nd that's just the beginning! It has:**

- **Dual Floppy Discs**
- **Full ASCII keyboard**
- **32 Remote Terminal capability with variable responses for each R/T**
- **Rugged new packaging**
- **Light pen or cursor control**
- **Increased Traffic RAM (4K)**
- **Expanded triggering capability**
- **Programmable scrolling**
- **Compatible with approved SEAFAC Test Plan**
- **... and much more**

**. . .such as CPM DOS and automatic test execution**



If you have a headache,
don't call your doctor;
call Fairchild at 301-428-6477.

**FAIRCHILD**
COMMUNICATIONS & ELECTRONICS COMPANY
*Telex: 89-2468 • TWX: 710-828-9700*
*20301 Century Boulevard • Germantown, Maryland 20874-1182*

**CIRCLE NO 76**

multaneously in shared memory. Both the current and the non-current structures possess the same format. Included in this format are a descriptor stack and a stack pointer. The bus-controller configuration includes a message-count register **(Fig 2a)**; the remote-terminal configuration includes a data-block address look-up table **(Fig 2b)**.

The 1553-bus side of the interface has access only to the current structure, but the subsystem host can access either the current or the non-current structure. The host selects between the structures by updating a bit in the configuration register or by setting the appropriate pin in hardware. The interface module handles memory-access contention between the subsystem and the 1553 bus by placing the host processor in a wait state.

The interface module provides three internal, 16-bit control registers: the interrupt-mask, configuration, and start/reset registers. The interrupt-mask register supports interrupt-on-condition operation, the configuration register supports the double-buffered memory and 1553-bus operations, and the start/reset register handles start and reset operations. You can also use the device to address external registers.

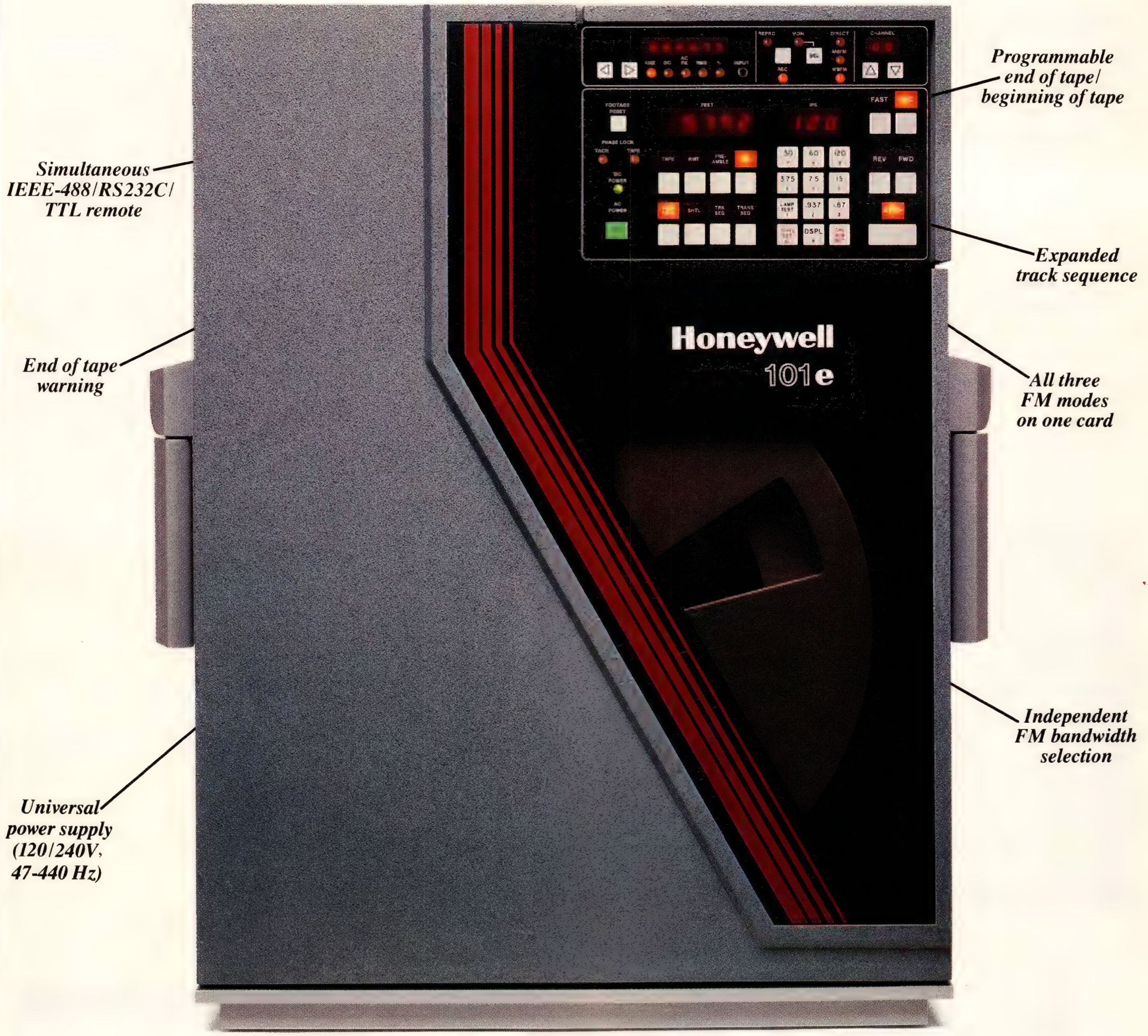
You can locate the descriptor stack anywhere within the 64k-byte memory space of the interface unit. If the BC/RTU/MT module is configured as a bus controller, the descriptor stack's entries comprise two words of message-transfer status followed by a reserved word and a data-block address pointer. If the BC/RTU/MT module is configured as a remote terminal, the final word is a 1553 received command word instead of a data-block address pointer. Because each entry in the stack is four words long, the stack pointer increments by four at the end of each transfer to prepare for the next 1553 transfer. **EDN**

## Author's biography

*Daryl C Josephson is a product marketing engineer at ILC Data Device Corp (Bohemia, NY). He obtained a BSEE from Clarkson University and a BA in music theory from the Crane School of Music, SUNY—College at Potsdam. He is a member of the society of automotive engineers, the audio engineering society, and the international MIDI association. Daryl is interested in computer-aided music.*

Article Interest Quotient (Circle One)
High 485 Medium 486 Low 487

# WHAT'S NEW.




Introducing the Honeywell Model 101e—an enhanced version of the rugged Model 101 that has proven its reliability in a wide range of applications over many years.

The new features of the Model 101e give you the greatest possible assurance of data accuracy by augmenting the many qualities of its predecessor.

Qualities like preamble recording with a "known" signal; microprocessor-controlled auto test for calibration verification at the speed *you* select; total system control via a direct-access panel; gentle tape handling; 5-year/5000-hour unprorated warranty on the ferrite heads; field services and a worldwide parts network unsurpassed for more than 30 years.

For more details, contact Darrell Petersen, Honeywell Test Instruments Division, Box 5227, Denver, CO 80217-5227. (303) 773-4835.

**Together, we can find the answers.**

**Honeywell**



CIRCLE NO 112

# THE NEWEST MILITARY STANDARD PRODUCTS ARE READY FOR INSPECTION.

Signetics has long been known as a leading source of military standard products, including JAN Class B & S, Military Drawings and Vendor Class B, as well as customer source control drawings.

But what many people don't realize is that these days we also pride ourselves on offering many of the newest, most innovative mil-standard products in the world. And that includes the first supplier with a JAN qualified leadless chip carrier.

For instance, we have a new family of high speed and registered Bipolar PROMs that are the fastest in the industry. This, coupled with our new CMOS EPROMs, makes us No. 1 in military standard programmable memories.

We also produce FAST™ logic, many high performance Linear IC's plus sequential and combinatorial PLDs.

If you need a 68000 microprocessor available to a military or DESC Drawing, see us.

In fact, Signetics now makes over 600 military standard integrated circuits, many of which are Signetics originated. Signetics military standard integrated circuits all comply to MIL-STD-833, Rev. C Paragraph 1.2.1. And, of course, all are backed by our zero defects warranty and a total customer service commitment from quote to product delivery.

Below are some of our innovative military standard IC's. Take a good look. We're sure they'll pass your inspection with flying colors.

For a copy of our brand new military data manual, including a complete list of all our military standard products, call 1-800-227-1817, Ext. 969D or send in the coupon.

FAST is a trademark of Fairchild Semiconductor Corporation.

## DATA COMMUNICATIONS

| | | |
|---|---|---|
| 2661/68661 | Enhanced Peripheral Comm I/F (EPCI) | Universal syn/async double buffered RxTx internal baud rate generator. Three versions with different baud rates. Speed: 1MHz |
| 2681/68681 | Dual UART (DUART) | Dual channel, quad buffered receiver. Double buffered transmitter. Independent baud rate selection. The 68681 is for nonmultiplexed bus processors like 68000. 2681 is for multiplexed bus processors like Intel/Zilog series. Speed: 1MHz |

## VME SYSTEM INTERFACE

| | | |
|---|---|---|
| 68154 | Interrupt generator IGOR | Interrupt generator providing for VME or VERSA bus, generates 7 bus interrupt requests. Speed: 11MHz |
| 68155 | Interrupt handler IVHAN | Accepts interrupts from 14 sources which are prioritized to one of 7 levels. Local master IACK cycle with vector from 68154. Speed: 10MHz |
| 68172 | VME bus controller buscon | VME bus controller interface circuit. Master/slave configurations, processor or DMA interface. Speed: 25MHz |

## LINEAR

| | |
|---|---|
| 5539 | 600V/$\mu$s High Frequency OP AMP |
| 5532 | Dual Low Noise OP AMP |
| 5534 | Low Noise OP AMP |
| 5205 | Wide Band High Frequency AMP |
| 5560 | SMPS Single-Ended Monolithic Controller |
| 5018 | 8-Bit Microprocessor Compatible D/A Converter |
| 521 | High-Speed Dual Differential Comparator/Sense Amplifier |
| 527 | Voltage Comparator |
| 529 | Voltage Comparator |
| 5521 | LVDT Signal Conditioner |
| 602 | 200 MHz Mixer, OSC |
| 604 | Narrow Band FM IF |
| 5512 | Transimpedance Amp for Fiber Optics |

## MICROPROCESSORS/MICROCONTROLLERS

| | | |
|---|---|---|
| 68000 | 16/32-bit MPU | 16-bit external/32-bit internal MPU; 17 general purpose 32-bit registers; 16MB linear address space. Speed: 6,8,10MHz |
| 8X305 | Microcontroller | Speeds: 200ns, 250ns |

## HIGH SPEED PROMs

| | |
|---|---|
| 82HS195 | 4K x 4 45NS |
| 82HS321A | 4K x 8 45NS |
| 82HS641A | 8K x 8 55NS |
| 82HS187 | 1K x 8 Registered PROM, Asynchronous |
| 82HS189 | 1K x 8 Registered PROM, Synchronous |

## EPROMs

27C64A 8K x 8 EPROM 200, 250 & 350 NS speeds
27C256 32K x 8 EPROM 200 & 250 NS speeds
27C641 8K x 8 EPROM Bipolar Pin-out 70 NS

## FAST LOGIC

| | |
|---|---|
| 54F00 | Quad 2-Input NAND Gate |
| 54F02 | Quad 2-Input NOR Gate |
| 54F04 | Hex Inverter |
| 54F08 | Quad 2-Input AND Gate |
| 54F10 | Triple 3-Input NAND Gate |
| 54F11 | Triple 3-Input AND Gate |
| 54F20 | Dual 4-Input NAND Gate |
| 54F32 | Quad 2-Input OR Gate |
| 54F38 | Quad 2-Input NAND Buffer, O/C |
| 54F64 | 4-2-3-2-Input AND/OR Invert Gate |
| 54F74 | Dual D-Type Flip-Flop |
| 54F86 | Quad 2-Input Exclusive-OR Gate |
| 54F109 | Dual J-K Positive Edge-Triggered Flip-Flop |
| 54F112 | Dual J-K Negative Edge-Triggered Flip-Flop |
| 54F113 | Dual J-K Negative Edge-Triggered Flip-Flop |
| 54F138 | 1-of-8 Decoder/Demultiplexer |
| 54F139 | Dual 1-of-4 Decoder/Demultiplexer |
| 54F151 | 8-Input Multiplexer |
| 54F153 | Dual 4-Line to 1-Line Multiplexer |
| 54F157A | Quad 2-Input Data Selector/Multiplexer |
| 54F161A | 4-Bit Binary Counter, Asynchronous Reset |
| 54F163A | 4-Bit Binary Counter, Synchronous Reset |
| 54F169 | 4-Bit Up/Down Binary Synchronous Counter |
| 54F175 | Quad D Flip-Flop w/Master Reset |
| 54F181 | Arithmetic Logic Unit |
| 54F194 | 4-Bit Bidirectional Universal Shift Register |
| 54F240 | Octal Inverting Bus/Line Driver, 3-State |
| 54F244 | Octal Bus/Line Driver, 3-State |
| 54F245 | Octal Bus Transceiver, 3-State |
| 54F251 | 8-Input Multiplexer, 3-State |
| 54F253 | Dual 4-Input Multiplexer, 3-State |
| 54F257A | Quad 2-Input Multiplexer, 3-State |
| 54F258A | Quad 2-Input Multiplexer, 3-State |
| 54F280A | 9-Bit Odd/Even Parity Generator/Checker |
| 54F283 | 4-Bit Adder |
| 54F367 | Hex Buffer/Driver, 3-State |
| 54F373 | Octal Transparent Latch, 3-State |
| 54F374 | Octal D Flip-Flop, 3-State |
| 54F381 | 4-Bit Arithmetic Logic Unit |
| 54F398 | Quad 2-Port Register |
| 54F521 | 8-Bit Identity Comparator |
| 54F534 | Octal D Flip-Flop, 3-State |

## PLDs

| | |
|---|---|
| 82S105 | Field Programmable Logic Sequencer |
| PLS159A | Field Programmable Logic Sequencer |
| PLS167 | Field Programmable Logic Sequencer |
| PLS168 | Field Programmable Logic Sequencer |
| PLS179 | Field Programmable Logic Sequencer |
| 82S100 | Field Programmable Logic Array |
| 82S153A | Field Programmable Logic Array |
| PLS173 | Field Programmable Logic Array |
| PLS161 | Field Programmable Logic Array |

Parts available in DIL, LCC or Flat Pack

One standard. 0 defects.

**Signetics**

a subsidiary of U.S. Philips Corporation

Please send me a copy of Signetics's new military data manual.

Name__________

Title__________

Company__________

Street__________

City__________

State__________ Zip__________

Send coupon to: Signetics Corporation, 811 E. Arques Ave., P.O. Box 3409, Sunnyvale, CA 94088-3409. Attn: Publication Services, M/S 27

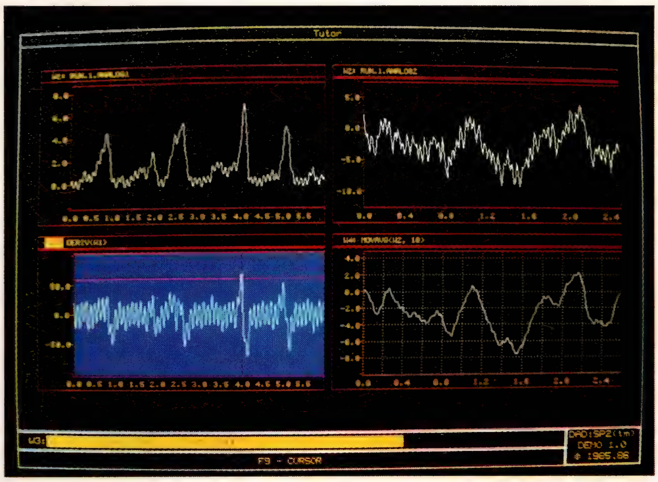
969

EDN's DSP Project—Part 2

# Wide choice of tools breaks down barriers to DSP design

*DSP design has been made easier. A varied assortment of DSP tools is now available to help you bypass the maze of algorithmic convolutions and guide you over the hurdles to creating and testing your DSP design with comparative simplicity. This second in EDN's 4-part series on digital-signal processing surveys the current field of tools that can help you implement DSP designs more quickly and directly.*

David Shear, *Regional Editor*



***This program lets you view either the acquired or created waveforms*** *along with the processed results. In this screen from Dadisp from DSP Systems, we see the original signals (W1 and W2) and then the results of the signal processing. Nor are you limited to just four windows—you can view as many as 64 separate windows at one time.*

You've heard of DSP, you've seen the variety of chips that are now available, and you've even considered using these whiz-bang devices in your projects. But every time you open a DSP application note you are overwhelmed by the complex math involved in understanding the algorithms. You could work through it but you haven't got the enormous amount of time it would take. You're not alone. Many have contemplated using DSP chips only to run into the same brick wall. Although some applications do require that you obtain in-depth knowledge about the algorithms you use, you can use other, more common algorithms, such as filters and FFTs, for many applications. Furthermore, no matter how esoteric the algorithm, the tools that assist you in the development of DSP-based projects are constantly improving. With these tools, you can quickly create the code for a DSP processor and then experiment with various approaches in software.

Assemblers are available for almost every DSP device. These packages accept your source code and create an object file in machine code. A listing file,

*Using a simulator gives you a front-row seat for viewing the operation of your software in a very controlled, stable environment.*

which is usually included in the package, combines the source and object files to ease the debugging process. The assembler can also produce the symbol table that your debugging tools use for symbolic debugging.

Working in conjunction with the assembler is the linker. A linker allows you to write the program in pieces, simulate them separately, and then link them together. The linker also simplifies the editing tasks because you can edit small program segments instead of one large file.

The assembler/linker is really the minimum tool set. With just these, you can create programs, burn them into PROM (or whatever program memory you are using), and try them out. And there are still those who successfully use some variation on this technique. But few tasks are more difficult—and frustrating—than debugging a system with the old "burn PROM, try, erase, burn again" method. Luckily, you now have many alternatives to this primitive development methodology.

**Watch your program run**

A simulator allows you to run your program on a host computer and watch any part of the program run, either by using breakpoints or by single-stepping. You don't obtain anything close to real-time execution or I/O operations with a simulator, but you can check out a surprisingly large percentage of a program.

Until recently, all simulators displayed information in similar ways. A representative simulator, such as Thomson Components-Mostek's PSimul for the TS68930/31, responds to specific commands and displays the requested data sequentially by scrolling, erasing all data previously shown. The Avocet Systems Avsim line for the TMS320 family, on the other hand, displays the registers, source code, I/O, and data memory values simultaneously and updates the appropriate section of the screen as the simulator runs **(Fig 1).**

Both approaches do give you complete control over the conditions under which the DSP chip is running. In addition, you can simulate external random events, from ports or memory for example, by creating disk files of such off-chip interactions. When the program under test requires external data, it then goes to the disk files. Likewise, in order to analyze the output, you can direct the simulator to place all output data into a disk file.

Simulators and other debugging tools are much easier to use if you can use symbols to refer to addresses and variables instead of hexadecimal numbers. Most of these tools read the symbol tables your assembler produces and then translate the symbols into the appropriate addresses.

A compiler converts high-level-language source code in one of two ways. Either it converts the source code directly into an object file written in machine code, or it


***Fig 1—Although the display is overpowering at first,*** *once you become familiar with the Avsim simulator from Avocet Systems you will find it very easy to use. The program updates the display as the simulation runs so you can see the change in the DSP chip as the program executes.*

first converts the source code into an assembly-language source file that you must then assemble. In any event, programming in a high-level language can make your job much easier. Instead of having to deal with multitudes of details required by assembly language, you can use the compiler to keep track of many of them.

Of course, the idea of using a high-level language in the DSP domain might seem ludicrous in itself at first. After all, the big advantage of a DSP chip is the very specialized instructions that streamline various algorithms. And high-level languages include not a single instruction that will multiply two numbers, accumulate the previous product, store the previous accumulation, and increment three pointers. So it seems that using a high-level language just reduces your slick DSP chip to the performance level of a general-purpose μP.

Although a high-level language does reduce performance, you have to keep in mind that a large portion of some DSP implementations doesn't involve dedicated number crunching. Therefore it makes sense to use assembly language for rapid number crunching and then take advantage of a high-level language to more easily move data and provide interfaces.

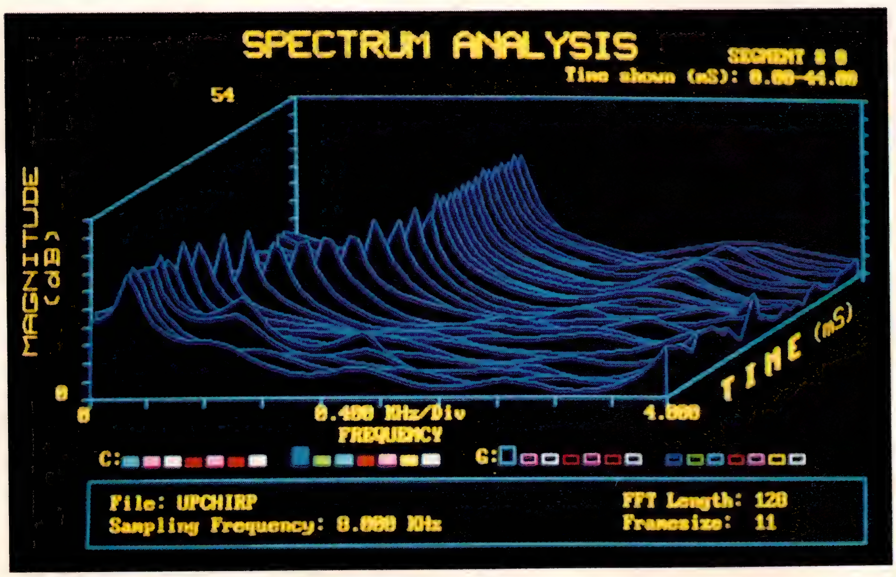
Optimizing compilers are beginning to surface that take advantage of the high-level language syntax and then optimize the resulting code for the parallel architecture inherent in many DSP chips. These compilers offer you the advantages of programming in a high-level language without sacrificing speed.

Three vendors currently provide compilers for high-level languages for the TI TMS320 family. Sky Computers has a C compiler that works with its SKY321 IBM-compatible development board and produces code for the TMS32010. They also have a C compiler for the TMS32020. The vendor claims its C is "compatible with Kernighan and Ritchie, with some exceptions." Some extensions let you use the specialized features of the TMS320 family. Because the output of the compiler in assembly language is not completely compatible with the TI assembler, however, you must use the assembler included in the package. If you want to program in Forth, you could use the combined software-hardware development system available from Forth Inc. This IBM PC-based system includes a real-time, multitasking, multiuser operating system based on the TMS32020/C25.

**Design DSP in blocks**

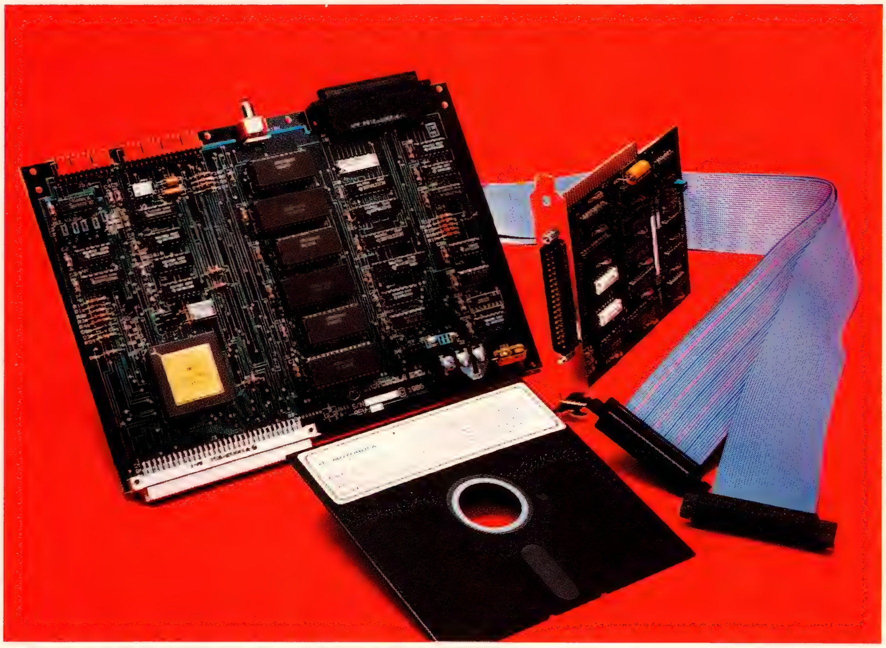
Computalker's Signal-Processing Language (SPL) compiler departs from the standard approach of high-level languages. SPL consists of blocks, written in assembly language, that represent different DSP functions, such as signal generators, filters, noise generators, and mixers. You create a design out of these functional blocks. Your code must run sequentially, however. And if you need data manipulation or control software beyond sequential operations, or if you need additional functions, you have to write it yourself in assembly language.

The use of high-level languages extends beyond the realm of the general-purpose DSP chips. The XL Series compilers from Weitek provide C or Fortran compila-




***A multitude of display options** are available from Hyperception's Hypersignal program. This 3-D display shows a spectrum of the input as a function of time. In this example, you can see that a signal starts at about 400 Hz and then moves to about 1200 Hz.*

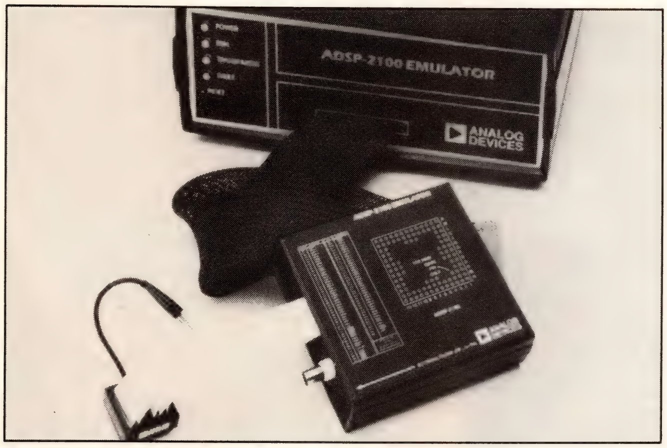
*High-level languages for DSP chips bring the same increased productivity to DSP chips that they bring to the general-purpose μP arena.*



***Most PC-based development systems exist inside the PC,*** *but the DSP56000ADS from Motorola resides primarily on an external board. A special PC based I/O card controls the board. This arrangement gives you much easier access to the hardware should you want to probe around.*

tion for the XL8000/32 series of attached processors. Included with the development system is a program that accepts the output of the compilers and optimizes the code to take advantage of the XL's parallel architecture.

Although assembly language currently prevails in simple DSP tools, many of the DSP chip vendors are in the process of making compilers for their product lines. As these products become available, high-level languages, with all their advantages, will play a major part in a broad range of DSP projects.




***Typical of most in-circuit emulators*** *is the Analog Devices ADDS-2150. An IBM PC controls the system, which consists of an emulator chassis and an emulation pod. Connected to the pod is a cable with the connector that plugs into the DSP chip's socket in the target system.*

A large number of DSP-based projects include a filter of some form or another. In the past, designing a filter was a long and laborious task. But now you have access to filter design packages **(Ref 1).** Using one of these packages, you enter the specifications of the filter you desire, and then the software calculates the coefficients to realize that filter. These tools dramatically increase your productivity and usually pay for themselves after one use.

The experiments in software you can perform eliminate a lot of real trial and error. For example, if you need a certain type of filter but the optimum design takes too long to execute, you can try the filter with different parameters and quickly see the tradeoff between speed of execution and the specific filter requirements.

The Digital Filter Design Package (DFDP) from Atlanta Signal Processors and Dispro from Signix are two such packages. They can take your requirements, provide an estimate of the filter length, calculate the coefficients, and then generate the code for a TMS32010/20. All you have to do is place the filter code in your program, which acquires the original sample and later handles the filtered sample **(Ref 1).** You can even create such exotic filters as multiband, a differentiator, or a Hilbert transform filter.

Atlanta Signal Processors has a package called the Algorithm Development Package, which is an IBM PC

add-in board based on either the TMS32010 or the TMS32020. It can digitize analog inputs and create analog output. The utility software allows you to acquire and edit signals, load your application program, debug it, and view waveforms on the PC's screen.

During the initial phase of a project, you have to decide on the basic approach. Some packages exist that can help you here, although they don't actually contribute any substantive elements to your design. Dadisp from DSP Systems allows you to experiment with various approaches by using functions such as trigonometric calculations, Fourier analysis, statistical analysis, and waveform generation. You see the results displayed quickly as graphics on the screen of an IBM PC. You can also divide the screen into as many separate windows as you want to show all stages of your algorithm. Dadisp costs $795 for an IBM PC; $2495 for a VAX, HP, or Sun workstation; and as much as $4995 for Masscomp (Westford, MA) systems.

Other packages are available for trying out various approaches at this very high level. Hyperception's $349 Hypersignal and $489 Hypersignal-Plus both let you explore different algorithms. These packages perform general-purpose signal-processing functions. Both run on the IBM PC and can interface with the TI XDS emulator or EVM evaluation module. You also can do

## For more information . . .

For more information on DSP tools mentioned in this article, circle the appropriate numbers on the Information Retrieval Service card or contact the following companies directly.

**Allen Ashley**
395 Sierra Madre Villa
Pasadena, CA 91107
(818) 793-5748
**Circle No 710**

**Analog Devices**
2 Technology Way
Norwood, MA 02062
(617) 329-4700
**Circle No 711**

**Ariel Corp**
110 Greene St, Suite 404
New York, NY 10012
(212) 925-4155
TLX 4997279
**Circle No 712**

**Atlanta Signal Processors Inc**
770 Spring Street NW, Suite 208
Atlanta, GA 30308
(404) 892-7265
**Circle No 713**

**AT&T Technologies**
555 Union Blvd
Allentown, PA 18103
(800) 372-2447
**Circle No 714**

**Avocet Systems Inc**
Box 490
Rockport, ME 04856
(207) 236-9055
TLX 467210
**Circle No 715**

**Computalker**
1119 Colorado Ave, Suite 115
Santa Monica, CA 90401
(213) 393-7781
**Circle No 716**

**Cybernetic Micro Systems**
Box 3000
San Gregorio, CA 94074
(415) 726-3000
TLX 171135
**Circle No 717**

**DSP Systems**
1 Kendall Square
Cambridge, MA 02139
(617) 577-1133
**Circle No 718**

**Forth Inc**
111 N Sepulveda Blvd
Manhattan Beach, CA 90266
(213) 372-8493
TLX 275182
**Circle No 719**

**Hewlett-Packard**
1507 Page Mill
Palo Alto, CA 94304
Call local office
**Circle No 720**

**Hyperception**
9550 Skillman LB125
Dallas, TX 75243
(214) 828-3508
**Circle No 721**

**Inmos Corp**
Box 16000
Colorado Springs, CO 80935
(303) 630-4362
**Circle No 722**

**Intersil Inc**
10600 Ridgeview Court
Cupertino, CA 95014
(408) 996-5000
TWX 910-338-0171
**Circle No 723**

**Microcraft Corp**
Box 513
Thiensville, WI 53092
(414) 241-8144
**Circle No 724**

**Moonshadow Software**
5016 Castlewood Dr
San Jose, CA 95129
(408) 446-2459
**Circle No 725**

**Motorola Inc**
Box 52073
Phoenix, AZ 85072
(512) 440-2039
**Circle No 726**

**NEC Electronics Inc**
401 Ellis Street
Mountain View, CA 94039
(415) 960-6000
TWX 910-379-6985
**Circle No 727**

**Oki Semiconductor**
650 N Mary Ave
Sunnyvale, CA 94086
(408) 720-1900
TLX 296687
**Circle No 728**

**Pacific Microcircuits Ltd**
240 H Street
Blaine, WA 98230
(800) 663-8986
**Circle No 729**

**Plessey Semiconductors**
9 Parker
Irvine, CA 92718
(714) 472-0303
TLX 701464
**Circle No 730**

**Signix Corp**
19 Pelham Island Rd
Wayland, MA 01778
(617) 358-5955
**Circle No 731**

**Sky Computers Inc**
Foot of John St
Lowell, MA 01852
(617) 454-6200
TLX 4991331
**Circle No 732**

**Texas Instruments**
Semiconductor Group
Box 809066
Dallas, TX 75380
(800) 232-3200, X700
**Circle No 733**

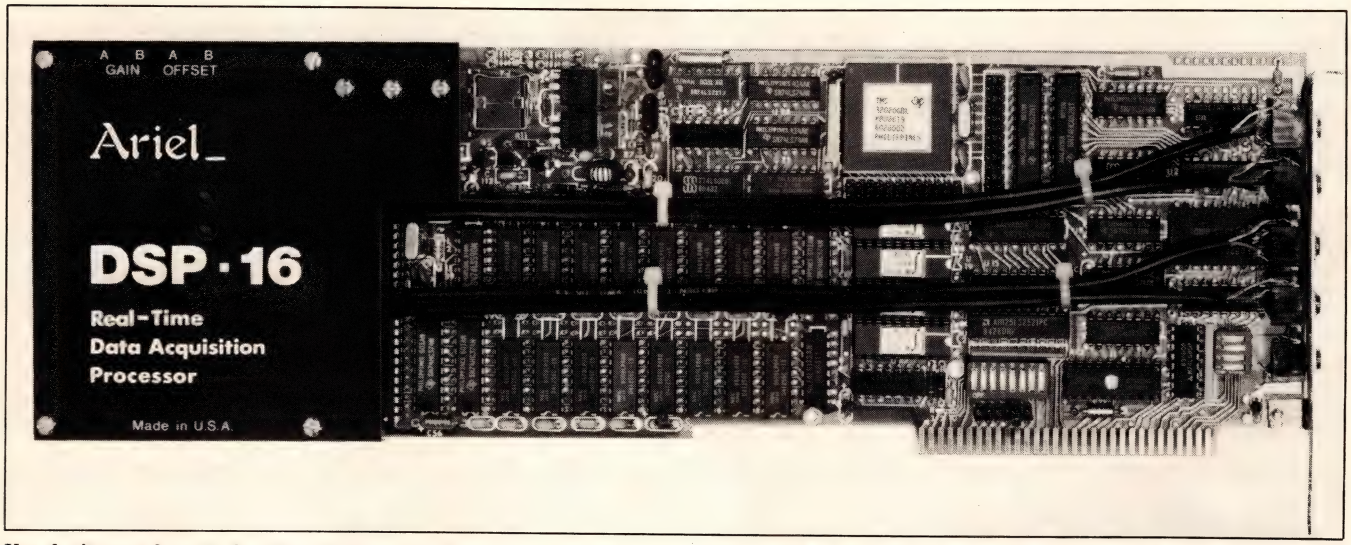
**Thomson Components-Mostek**
1310 Electronics Dr
Carrollton, TX 75006
(214) 466-6000
TLX 730643
**Circle No 734**

**Weitek Corp**
1060 E Arques Ave
Sunnyvale, CA 94086
(408) 738-8400
TWX 910-339-9545
**Circle No 735**

**Whitman Engineering**
Box 9675
Fort Collins, CO 80525
(303) 493-2210
**Circle No 736**

**Zoran**
3450 Central Expressway
Santa Clara, CA 95051
(408) 720-0444
**Circle No 737**

*Hardware tools are available to help you complete your project by monitoring your system operating in real time.*




***You don't even have to build any hardware*** *to prove an algorithm in real time with real analog signals. The DSP-16 PC-based development board from Ariel has two 16-bit ADCs able to run at 50 kHz, a 512k-byte data buffer, a 40-MHz TMS320C25, and two 16-bit, 50-kHz DACs.*

signal processing on intermediate results by stopping your application program at any time and loading sections of memory into these packages for analysis. This type of analysis is very useful when debugging an algorithm because intermediate results can be analyzed in the time or frequency domain. You then have access to over 20 different graphics displays to display the analysis results.

When you just want to learn DSP fundamentals or test simple algorithms, consider the $99 Spia package from Moonshadow Software. This inexpensive package allows you to perform various functions, such as convolution, correlation, and Fourier transforms, on data you specify. The results are available on screen.

**Eventually, it must be tried**

All good projects must come to an end. Eventually your project must operate in the real world. To help meet this end, you have various options involving in-circuit emulators or IBM PC add-in cards.

An in-circuit emulator is an extremely valuable tool when debugging complex systems. When using such a device you replace the DSP chip with an emulation plug. Your software is then run in a real-time, real-world environment. Most DSP chip vendors offer an emulator.

Emulators are absolutely invaluable to complex projects. They give you complete control over the target system. Furthermore, if your program fails, many of these systems can trace how it failed. Real-time interaction with the target system allows you to find problems that don't pop up in the sheltered world of a simulator.

Although you must sacrifice flexibility, you might want to consider a board that plugs into an IBM PC. These boards, with the appropriate software, transform your PC into an efficient development system. Your code is loaded into the board and then run on the chip you are using. Some boards include an ADC and a DAC for testing even the acquisition and transmission of analog signals—an ideal way of testing your signal processing algorithms.

All these software and hardware tools for DSP design let you successfully complete projects without being extremely experienced in DSP algorithms. They cut down on development time as well. In the third part of this series, we will use some of these tools to develop an acoustic transponder. **EDN**

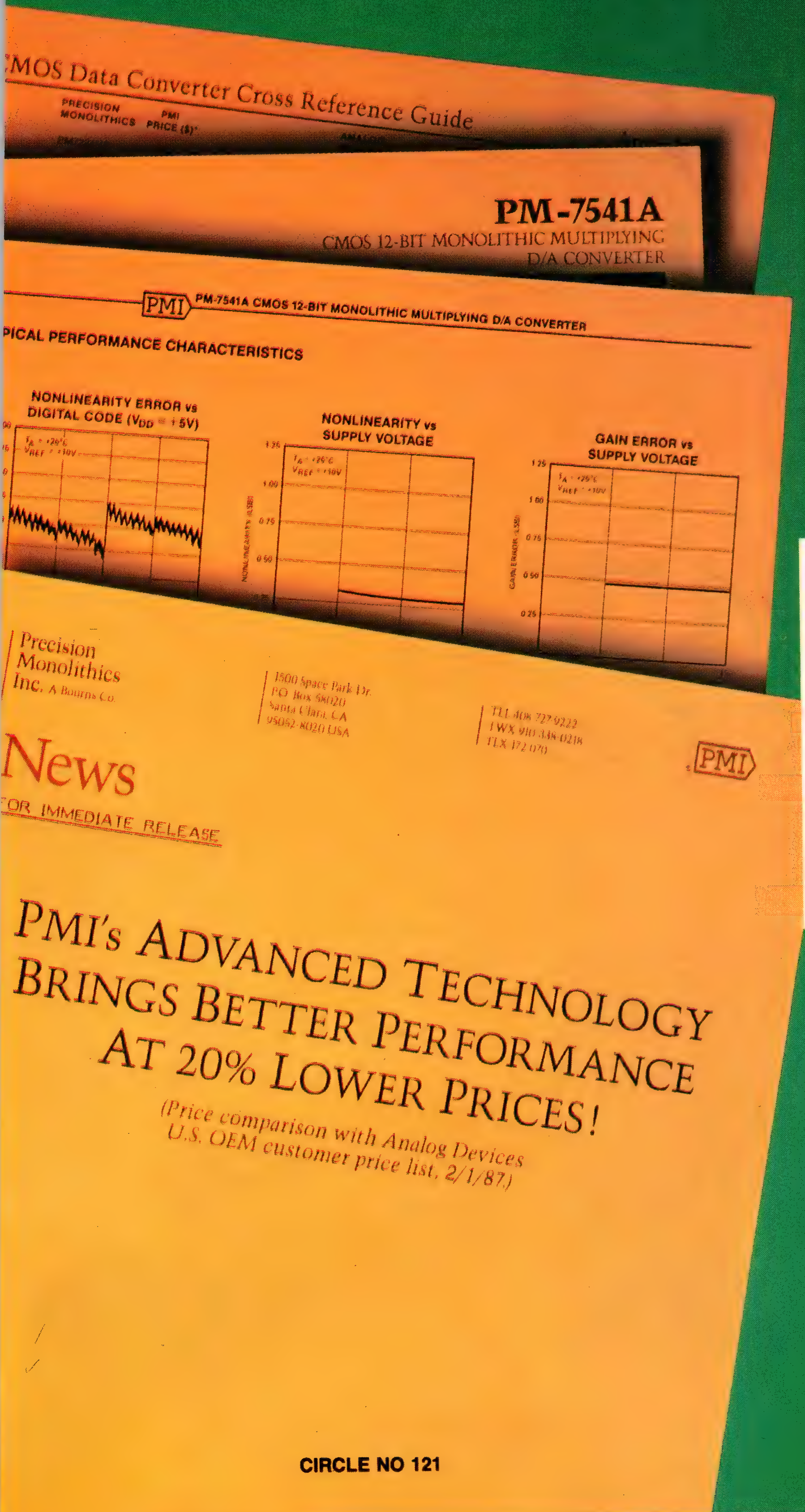
*Table begins on pg 191*

## References

1. Cushman, Robert, "DSP-filter software offers design help to novices," *EDN*, July 10, 1986, pg 152.
2. Cushman, Robert, "Novel CAD software generates DSP coefficients painlessly," *EDN*, August 18, 1983, pg 137.
3. Cushman, Robert, "Sophisticated development tool simplifies DSP-chip programming," *EDN*, September 29, 1983, pg 165.

**Article Interest Quotient (Circle One)**
**High 497 Medium 498 Low 499**

# NEED CMOS DACS? GET THE FACTS




- Better Thin Film:
  - Absolute $T_c$ (< 50ppm/°C)
  - Tighter linearity and temperature specifications
- Improved Laser Trimming:
  - Does not open passivation layer
  - Superior reliability and long-term stability
- Higher yields result in 20% lower prices. *(Price comparison with Analog Devices U.S. OEM price list, 2/1/87)*
- Off-the-shelf from local distributor stock.

| | |
|---|---|
| ADC-908 | PM-7533 |
| ADC-0820* | PM-7541 |
| DAC-8408 | PM-7541A |
| DAC-8012 | PM-7542* |
| DAC-8212 | PM-7543* |
| DAC-8222* | PM-7545 |
| DAC-8248* | PM-7548 |
| PM-7226 | PM-7574 |
| PM-7524 | PM-7645 |
| PM-7528 | |

**Available 4th Quarter 1987*

Get the facts . . . circle the reader service number for PMI's CMOS converter booklet.

Can't wait? Call 1-800-JIT-CMOS

Precision Monolithics Inc.
A Bourns Company
Santa Clara, California, USA

PMI®

*The precision solution.*

CIRCLE NO 121

We've lowered prices on the HP 54100A/D 1 GHz Digitizing Oscilloscopes. So you can get a great, general-purpose HP scope for substantially less.

The HP 54100A, originally $17,600, is now just $12,900.**

The HP 54100D, originally $19,300, is now $17,600.**

A savings of $4,700 and $1,700, respectively!

You'll appreciate the savings all the more when you discover everything our scopes have to offer: automatic signal scaling and instrument setup, automatic pulse parameter measurements, waveform storage, HP-IB control, direct output to printers and plotters, and more.

## Call HP today!

Take advantage of our lower prices now. Contact your local HP sales office listed in the telephone directory white pages. Ask for the electronic instruments department.

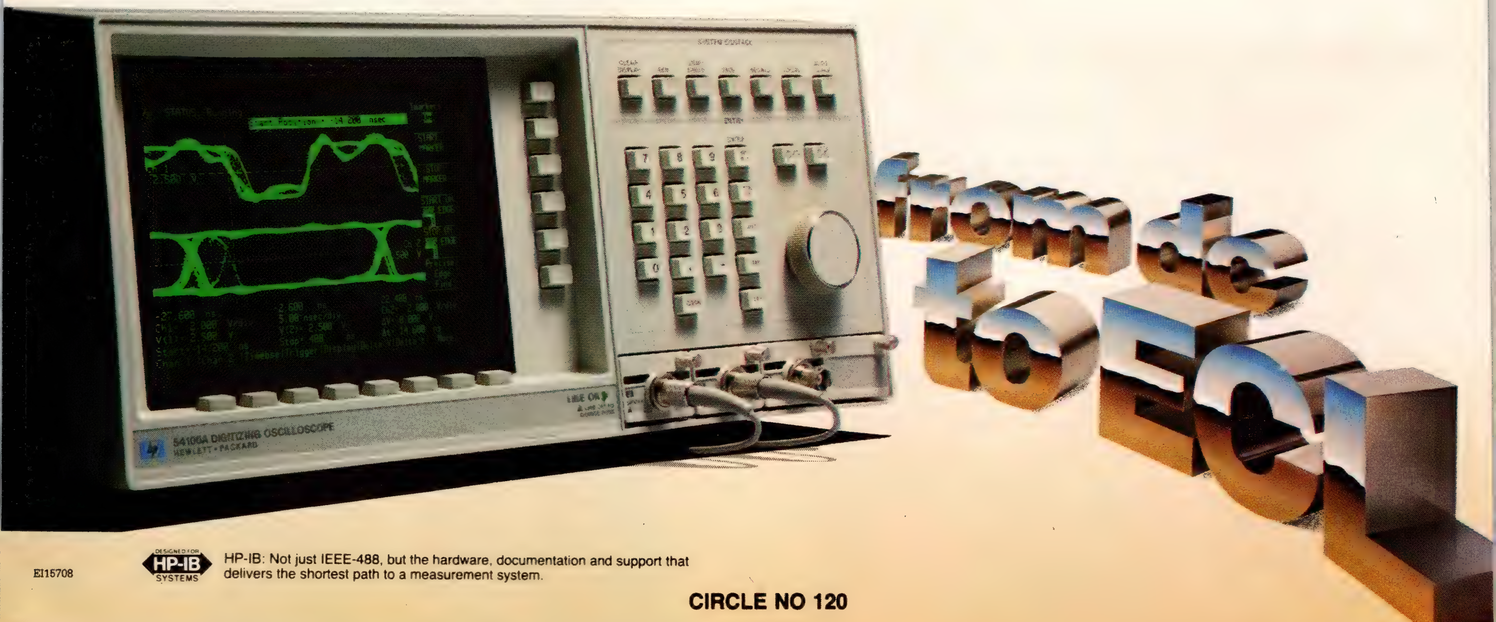
*HP 54100A only. **U.S.A. price only.

HEWLETT PACKARD

we never stop asking

What if...

# Save $4,700*
## on a great 1 GHz scope!




EI15708

DESIGNED FOR HP-IB SYSTEMS

HP-IB: Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path to a measurement system.

CIRCLE NO 120

# SOFTWARE TOOLS FOR DSP DESIGN

| VENDOR | PRODUCT | DSP DEVICE SUPPORTED | PRICE ($) | COMPUTER OR OPERATING SYSTEM | NOTES |
|---|---|---|---|---|---|
| **ASSEMBLERS:** | | | | | |
| ALLEN ASHLEY | MAC320<br>MAC32025 | TMS32010<br>TMS320C25/20 | 150<br>150 | MS-DOS<br>MS-DOS | |
| ANALOG DEVICES | ADDS-2121<br>ADDS-2110 | ADSP-2100<br>ADSP-2100 | 450<br>2850 | PC<br>VAX (VMS) | INCLUDES SIMULATOR |
| ATLANTA SIGNAL PROCESSORS | TMSAIBM | TMS32010 | 200 | PC | |
| AT&T | DSP16-SL<br>DSP32-SL | DSP16<br>DSP32 | 500–1500<br>500–1500 | MS-DOS, UNIX<br>MS-DOS, UNIX | INCLUDES SIMULATOR<br>INCLUDES SIMULATOR |
| AVOCET | AVMAC32010<br>AVMAC32020 | TMS32010<br>TMS32020 | 349–995<br>349–995 | MS-DOS, UNIX<br>MS-DOS, UNIX | |
| COMPUTALKER CONSULTANTS | TASSM<br>TAS20<br>TAS25 | TMS32010<br>TMS32020<br>TMS320C25 | 190–325<br>325<br>325 | CP/M, APPLE-DOS, MS-DOS<br>CP/M, MS-DOS<br>CP/M, MS-DOS | |
| CYBERNETIC MICROSYSTEMS | CYS320 | TMS32010 | 295 | PC | |
| MICROCRAFT | ASM-10 | TMS32010 | 129 | PC | |
| MOTOROLA | DSP56000 SASM | DSP56000 | 295–3000 | PC, SUN 3, VAX | INCLUDES SIMULATOR |
| NEC | ASM77<br>77C25 ASSEMBLER<br>RA77230<br>SW7281 | UPD7720A/C20A<br>UPD77C25<br>UPD77230<br>UPD7281 | 900–2500<br>500<br>900<br>600 | PC, INTEL, VAX<br>PC<br>PC<br>PC, VAX | INCLUDES PC-BASED EVALUATION BOARD<br>INCLUDES SIMULATOR |
| OKI SEMICONDUCTOR | ASM92 | MSM6992 | N/A | MS-DOS | SUPPLIED WITH EMU92 OR EM92L EMULATORS |
| PACIFIC MICROCIRCUITS | TMS32020 MACROASSEMBLER/LINKER<br>TMS320C25 MACROASSEMBLER/LINKER | TMS32020<br>TMS320C25 | 395<br>395 | PC<br>PC | |
| TEXAS INSTRUMENTS | ASSEMBLER/LINKER<br>ASSEMBLER/LINKER | 1ST GENERATION 320<br>2ND GENERATION 320 | 500<br>500 | PC, VAX<br>PC, VAX | |
| THOMSON/ MOSTEK | PSIMAC | TS68930/31 | 295–1500 | PC, VAX | |
| ZORAN | VSPA | VSP FAMILY | 250 | PC | |
| **SIMULATORS:** | | | | | |
| ALLEN ASHLEY | EMU320 | TMS32010 | 200 | PC | |
| ANALOG DEVICES | ADDS-2122<br>ADDS-2110 | ADSP-2100<br>ADSP-2100 | 975<br>2850 | PC<br>VAX | INCLUDES ASSEMBLER |
| AT&T | DSP16-SL<br>DSP32-SL | DSP16<br>DSP32 | 500–1500<br>500–1500 | MS-DOS, UNIX<br>MS-DOS, UNIX | INCLUDES ASSEMBLER<br>INCLUDES ASSEMBLER |
| AVOCET SYSTEMS | AVSIM32010<br>AVSIM32020 | TMS32010<br>TMS32020 | 379<br>379 | MS-DOS<br>MS-DOS | |
| COMPUTALKER CONSULTANTS | S320 | TMS32010 | 190–325 | CP/M, APPLE DOS, MS-DOS | |
| INMOS | D703 | A100 | 250 | PC | |
| MOTOROLA | DSP56000SASM | DSP56000 | 295–3000 | PC, SUN 3, VAX | INCLUDES ASSEMBLER |

## SOFTWARE TOOLS FOR DSP DESIGN *(Continued)*

| VENDOR | PRODUCT | DSP DEVICE SUPPORTED | PRICE ($) | COMPUTER OR OPERATING SYSTEM | NOTES |
|---|---|---|---|---|---|
| **SIMULATORS:** | | | | | |
| NEC | SIM77<br>SM77230<br>SW7281 | UPD7720A/C20A<br>UPD77230<br>UPD7281 | 900<br>1800<br>600 | PC, INTEL<br>VAX<br>PC, VAX | INCLUDES ASSEMBLER |
| TEXAS INSTRUMENTS | SIMULATOR<br>SIMULATOR | 1ST GENERATION 320<br>2ND GENERATION 320 | 1500<br>1500 | PC, VAX<br>PC, VAX | |
| THOMSON/ MOSTEK | PSIMUL | TS68930/31 | 1500 | VAX | |
| ZORAN | VSPS | VSP FAMILY | 3000-5000 | PC, VAX | |
| **COMPILERS:** | | | | | |
| COMPUTALKER CONSULTANTS | SPL | TMS32010 | 560 | PC | FUNCTIONAL COMPILER |
| FORTH | FB-320 | TMS32020/C25 | 3850 | PC | MULTITASKING POLYFORTH, INCLUDES ASSEMBLER INCLUDES PC-COMPATIBLE DEVELOPMENT BOARD WITH RAM, ADC, AND DAC |
| SKY COMPUTERS | SKY-C<br>SKY-C<br>SKY-C | TMS32020<br>TMS32020<br>TMS32010 | 1500<br>3500<br>500 | PC<br>VAX, SUN<br>PC | C COMPILER WITH DEVELOPMENT PACKAGE<br>C COMPILER WITH DEVELOPMENT PACKAGE<br>C COMPILER (SOLD ONLY WITH SKY321 HARDWARE) |
| WEITEK | XL-C<br>XL-FORTRAN | XL8000/32<br>XL8000/32 | 4000<br>4000 | PC/AT, VAX<br>PC/AT, VAX | BOTH COMPILERS INCLUDE PARALLELIZER, ASSEMBLER/ LINKER, AND SIMULATOR DEBUGGER |
| **SPECIALTY SOFTWARE:** | | | | | |
| ATLANTA SIGNAL PROCESSORS | DFDP | 1ST AND 2ND GENERATION 320 | 1195 | PC | DIGITAL FILTER DESIGN PACKAGE, INCLUDES CODE GENERATION |
| INTERSIL | EVK-128 | 29C128 | 799 | PC | FILTER DESIGN PACKAGE, INCLUDES PC-COMPATIBLE DEVELOPMENT BOARD |
| PACIFIC MICROCIRCUITS | DISPRO V.15 | N/A | 1150 | PC | FILTER DESIGN PACKAGE |
| PLESSEY | PDSP DEMONSTRATOR | PDSP1601, 1640, 16112, 16316 | FREE | PC | |
| SIGNIX | DISPRO 1.5<br>DISPRO/ARBITFIR-PM<br>DISPRO/ARBITFIR-FSW<br>CODEGEN/320 | N/A<br>N/A<br>N/A<br>TMS32010/20/C25 | 995<br>295<br>345<br>95 | PC<br>PC<br>PC<br>PC | FILTER DESIGN PACKAGE<br>ARBITRARY MAGNITUDE RESPONSE FIR FILTER DESIGN<br>ARBITRARY MAGNITUDE RESPONSE FIR FILTER DESIGN<br>CODE GENERATION |
| TEXAS INSTRUMENTS | DFDP | 1ST AND 2ND GENERATION 320 | 1195 | PC | DIGITAL FILTER DESIGN PACKAGE, INCLUDES CODE GENERATION |
| WHITMAN ENGINEERING | MADCAP<br>TMS320 DEVELOPMENT SYSTEM | N/A<br>TMS32010 | 995<br>1595 | PC, APPLE II<br>PC | SUPERVISORY SYSTEM WITH SIGNAL GENERATION AND ANALYSIS<br>ENHANCED MADCAP. COMPLETE TMS32010 DEVELOPMENT SYSTEM WHEN USED WITH TI-SPEECH BOARD |
| ZORAN | DFPS | DFP FAMILY | 995–1495 | PC, VAX | FILTER DESIGN PACKAGE |

## IN-CIRCUIT EMULATORS FOR DSP DESIGN

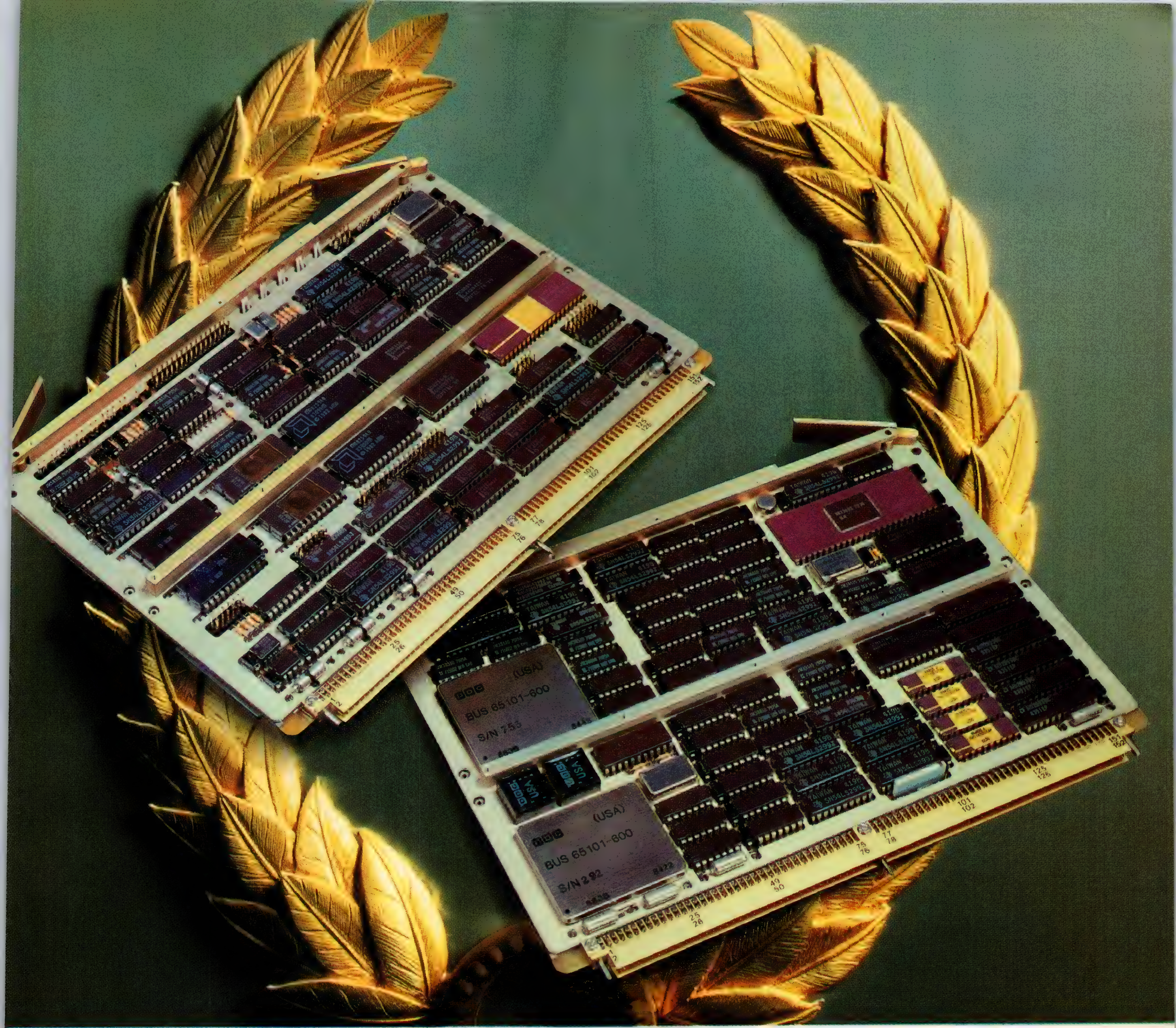
| VENDOR | PRODUCT | DSP DEVICE(S) SUPPORTED | PRICE($) | SUPPORT EQUIPMENT | NOTES |
|---|---|---|---|---|---|
| ANALOG DEVICES | ADDS-2150 | ADSP-2100 | 8450 | PC OR HOST | |
| AT&T | DSP16-DS<br>DSP32-DS | DSP16<br>DSP32 | 3000<br>3000 | PC OR HOST<br>PC OR HOST | |
| HEWLETT-PACKARD | HP64285S | TMS32010 | 4700 | HP64000 | |
| NEC | EVAKIT-7720B<br>EVAKIT-77230 | UPD7720A/C20A<br>UPD77230 | 2500<br>8900 | PC OR HOST<br>PC OR HOST | INCLUDES PROGRAMMER FOR EPROM 77P20 |
| OKI SEMICONDUCTOR | EMU92<br>EMU92L | MSM6992<br>MSM6992 | 8750<br>3750 | PC<br>PC | INCLUDES ASSEMBLER AND DEBUGGER |
| TEXAS INSTRUMENTS | TMS32010 EVM<br>TMS32020/C25 EVM<br>TMS320C10 XDS/22<br>TMS320C25 | TMS32010<br>TMS32020/C25<br>1ST GENERATION 320<br>2ND GENERATION 320 | 1000<br>4000<br>8500<br>13500 | PC OR HOST<br>PC OR HOST<br>PC OR HOST<br>PC OR HOST | |
| THOMSON/MOSTEK | EVAPSI | TS68930/31 | 3000 | PC OR HOST | INCLUDES SOFTWARE LIBRARY |

## IBM PC-BASED DEVELOPMENT BOARDS FOR DSP DESIGN

| VENDOR | PRODUCT | DSP DEVICE(S) SUPPORTED | PRICE ($) | ADC | DAC | RESOLUTION (BITS) | ADC SAMPLE RATE (KHz) | DAC OUTPUT RATE (KHz) | NOTES |
|---|---|---|---|---|---|---|---|---|---|
| ARIEL | DSP-16 | TMS32020/C25 | 2495 | 2 | 2 | 16 | 50 | 50 | INCLUDES APPLICATION SOFTWARE AND DSPBUG DEVELOPMENT SOFTWARE |
| ATLANTA SIGNAL PROCESSORS | ADP<br>320/PC-20 | TMS32010<br>TMS32020 | 1995<br>995 | 1 | 1 | 12 | 30 | 250 | ALGORITHM DEVELOPMENT PACKAGE. DAUGHTER BOARD, ALLOWS 32020 DEVELOPMENT ON THE ADP |
| DALANCO SPRY | MODEL 10 | TMS32010 | 850 | 1 | 1 | 12 | 80 | 80 | INCLUDES APPLICATION SOFTWARE AND DEBUG320 DEBUGGER |
| FORTH | FB-320 | TMS32020/C25 | 3850 | 1 | 1 | 16 | 50 | 50 | INCLUDES ASSEMBLER AND POLYFORTH COMPILER |
| INMOS | B009-1<br>D704 | A100<br>A100 | 4500<br>7500 | | | | | | PC-BASED A100 DEVELOPMENT B009-1 + 32-BIT TRANSPUTER/1M DYNAMIC RAM + SOFTWARE |
| MOTOROLA | DSP56000 ADS | DSP56000 | 3000 | | | | | | EVALUATION BOARD AND PC INTERFACE INCLUDED |
| OKI SEMICONDUCTOR | DSP EVALUATION BOARD | MSM6992 | 600 | | | | | | INCLUDES CONTROL/MONITOR PROGRAM |
| PACIFIC MICROCIRCUITS | TMS32020 | TMS32020 | 1995 | 1 | 1 | 16 | NA | NA | INCLUDES MONITOR SOFTWARE AND ASSEMBLER |
| | TMS320C25 | TMS320C25 | 2595 | 1 | 1 | 16 | NA | NA | INCLUDES MONITOR SOFTWARE AND ASSEMBLER |

## IBM PC-BASED DEVELOPMENT BOARDS FOR DSP DESIGN *(Continued)*

| VENDOR | PRODUCT | DSP DEVICE(S) SUPPORTED | PRICE ($) | ADC | DAC | RESOLUTION (BITS) | ADC SAMPLE RATE (KHz) | DAC OUTPUT RATE (KHz) | NOTES |
|---|---|---|---|---|---|---|---|---|---|
| PACIFIC MICROCIRCUITS | DSP-16 | TMS32020/C25 | 2495 | 2 | 2 | 16 | 50 | 50 | INCLUDES APPLICATION SOFTWARE AND DSPBUG DEVELOPMENT SOFTWARE |
| SKY COMPUTERS | SKY-321 | TMS32010 | 1700 | | | | | | INCLUDES ASSEMBLER, DEBUGGER, AND APPLICATIONS SOFTWARE |
| TEXAS INSTRUMENTS | SWDS | TMS32020/C25 | 4000 | | | | | | INCLUDES ASSEMBLER AND SOFTWARE LIBRARY |
| WEITEK | XL-DEV. BOARD SET | XL8000 | 10,000 | | | | | | BOTH INCLUDE RUN-TIME ENVIRONMENT SOFTWARE |
| | XL-DEV. BOARD SET | XL8032 | 10,500 | | | | | | |
| ZORAN | VSPD | VSP | 3000 | | | | | | INCLUDES DEBUGGER AND SOFTWARE LIBRARY |
| | VSPE | VSP | 1800 | | | | | | INCLUDES DEBUGGER AND SOFTWARE LIBRARY |
| | PSPX | VSP | 1000 | | | | | | INCLUDES DEBUGGER AND SOFTWARE LIBRARY |
| | DFPB | ZR733301-815 | 3000 | | | | | | INCLUDES DEBUGGER |
| | DFPB | ZR733301-415 | 2400 | | | | | | INCLUDES DEBUGGER |




# Mil spec Multibus,* Intel compatible and CMOS!

All these features now available in one mil spec computer product: Plessey Microsystems PMM 86.

Realise the full benefits of CMOS: power requirements reduced by as much as 75%, smaller and lighter packaging, and no compromise in performance.

All these and the traditional PMM 86 benefits add up to the military and severe environment product range for now and the future.

PMM 86 has inherent multiprocessor capability with 16-bit 8086 and 80286 processors and their arithmetic coprocessor counterparts. All PMM 86 systems have comprehensive built-in test (BITE) and still maintain full Intel Multibus SBC compatibility.

Plessey offers support for the iRMX 86 operating system giving both a run-time and a software development environment. ADA products from major vendors have been targeted to PMM 86.

Contact your nearest Plessey Microsystems office.

**PLESSEY**

**USA:** One Blue Hill Plaza, Pearl River, New York 10965.
Telephone: (914) 735 4661. TWX: 710 541 1512.
**France:** BP 74. 7-9 rue Denis Papin, 78194 Trappes.
Telephone: (1) 30.51.49.52. Telex: 696441.
**Germany:** D-6090 Rüsselsheim, Bahnhofstraße 38.
Telephone: (061 42) 680 04. Telex: 1761 4293.
**United Kingdom:** Water Lane, Towcester, Northants. NN12 7JN.
Telephone: (0327) 50312. Telex: 31628.

**CIRCLE NO 116**

**Intel trademark* *PLESSEY and the Plessey symbol are trade marks of The Plessey Company plc.*


HIGH PERFORMANCE.
© 1987, Avocet Systems, Inc. All rights reserved. VAX is a trademark of DEC. Unix is a trademark of AT&T. Xenix is a trademark of Microsoft. CP/M is a trademark of Digital Research.

# SOMETIMES, THE ACID TEST OF OUR MICROPROCESSOR DEVELOPMENT TOOLS IS UP IN THE AIR.

Two miles up, in the belly of a U2 jet, the U.S. Government is now tracking acid rain and radioactive particles with a just-developed device called an Upper Air Sampler.

But months earlier, with expensive development hardware on the blink, timely completion of the project was in real jeopardy.

Luckily, Avocet was called to the rescue. And within 48 hours we came through. With "the best software development tools" their design engineer had ever seen.

Not to mention, down-to-earth prices.

**Let Avocet turn your PC or VAX into a powerful, integrated development system in 48 hours, even overnight.**

Avocet can help you turn more good ideas into more real products in less time.

Just call us now and we'll get you up and running—with everything you need to turn your computer into a personal, professional development system.

All at a modest price. From a single source. Backed by the reassurance of a technical hotline. So friendly, knowledgeable support is always as close as your phone.

No wonder design engineers with no time to spare come to us first—and keep coming back smiling.

**Any similarity to Intel, Hitachi or Motorola is purely intentional.**

Avocet's professional quality AVMAC™ assemblers run on any PC-compatible with DOS or Xenix. And on VAX Unix. Just released, *AVMAC Version 2.0* has major speed improvements to assure you lightning-fast assembly. Plus, enhanced compatibility with Intel, Hitachi, Motorola & other chip makers—so you can convert existing code more easily than ever before.

Each AVMAC package comes complete with our AVLINK™ linker, AVLIB™ librarian, AVREF™ cross-reference generator and new 200+ page AVMAC *User's Guide*—all the assembly tools you want and need.

After assembly, check your program with AVSIM™—widely acclaimed as the best simulator/debugger in the industry. AVSIM tests target $\mu$P code right on your PC—with no special hardware. It's crashproof. And what you see is what you get: AVSIM's full-screen display gives you instant visual access to the entire CPU—registers, memory, I/O ports, even attached peripheral chips.

**Target Microprocessor Families Supported**

| | | |
|---|---|---|
| 1802/1805 | 68000/68010 | COP400 |
| 6502/65C02 | 68020 | HD64180 |
| 6801/6301 | 8048/8041 | NEC 7500 |
| 6804 | 8051/8052 | TMS-32010 |
| 6805/6305 | 8085 | TMS-32020 |
| 6809 | 8096 | Z8 |
| 68HC11 | F8/3870 | Z80 |

**Host Operating Systems**

CP/M DOS PC Xenix VAX Unix

AVMAC Macro Assemblers ................ from $349
AVSIM Simulator/Debuggers ............. from $379
Other Development Tools ................ Call

**CALL TOLL-FREE**
**800-448-8500***

to order or receive our latest catalog of microprocessor development tools

**Try before you buy.**

Order your AVMAC assembler and AVSIM simulator/debugger today and we'll include a special demo kit for both. Try the demo for 30 days. If you're not satisfied for any reason, return the unopened products for a full refund, less the $35 demo/documentation kit which is yours to keep.

Avocet Systems. We help you get your job done, on time and on budget.


*Avocet delivers all the tools you need—in 48 hours or less. Ask about our AVPROM™ and AVPAL™ programmers. And our NEW 8051 in-circuit emulator, development boards, AVPAS 51™ cross-compiler—and AVKIT,™ the total Unix toolbox for DOS, including the incomparable VI editor.*

Avocet Systems, Inc., 120 Union Street
P.O. Box 490BH, Rockport, Maine 04856
*Outside US and in ME, call (207) 236-9055
TLX: 467210 AVOCET CI FAX: (207) 236-6713

CIRCLE NO 115

AVOCET SYSTEMS, INC.®

THE SOURCE FOR PERSONAL $\mu$P DEVELOPMENT TOOLS.


AT&T Single Chip DSPs:
the first and the fastest.

# Now AT&T offers the world's first floating point and fastest fixed point DSPs.

Only AT&T can give you a complete single-chip Digital Signal Processor solution for all your analog and digital applications. Because, only AT&T has a single-chip floating point DSP in full production, as well as the fastest fixed point DSP available.

**Speed and flexibility.**
The AT&T DSP32 has a 32-bit floating format with 24 bits of precision. It has an on-chip CAU that allows it to perform like a 16-bit microprocessor with 32-bit floating point capabilities. This makes precision possible over a wider range, so essential for high tech applications such as computer aided design, image processing and speech compression.

If your requirement is for faster speeds, our fixed point DSP16 operates at 55 ns. It is the first single-chip DSP to approach "building block" speeds.

**Easier programming, development and debugging.**
AT&T's DSPs make it easier to develop algorithm implementations. Unlike competitive DSPs, AT&T DSPs are programmed using high level C-like Syntax, which is equation-like and much easier to program. AT&T also offers a complete single-board system for the development and real-time evaluation of your DSP programs. Plus, we offer a complete UNIX® and MS*-DOS software library for creating, testing and debugging applications programs.

**Single chip means savings.**
So, whatever your applications: voice signal filtering, speech and video signal compression, spectral analysis, graphics and computer-aided design, AT&T's single-chip DSPs can cut your development time as well as cutting power consumption and board area.

And, of course, AT&T Bell Laboratories' ongoing R&D will assure you that AT&T will stay at the forefront of DSP technology.

For more information, call **1 800 372-2447**, or send the reply coupon. In Europe, call AT&T Microelectronics in Munich, Germany at 089/95970, Telex 5216884. In Singapore, call 2508422/2533722, Telex RS21473/RS55038. Let us show you why AT&T is the only DSP supplier with a complete single-chip solution for all your analog and digital applications.

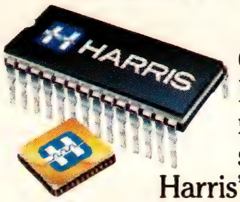
AT&T, Dept. 203130–Leads, 555 Union Blvd., Allentown, PA 18103 EDN 082087
Please send me more information about AT&T's DSPs.

Name ____________________
Title ____________________
Company ____________________
Address ____________________
City ____________________
State ____________ Zip ____________
Telephone (        ) ____________________

**AT&T**
**The right choice.**
**CIRCLE NO 124**

# If reliable computers are important to you, imagine what they mean to him.

## Our new 6-transistor 883C compliant 8K x 8 static RAMs.




Commodity-quality static RAMs can't cut it in the military, but now there's a static CMOS RAM that can: Harris' HM-65642.

It's a monolithic 883C certified RAM available in volume off-the-shelf, with impressive performance features...

- 6-T memory cell for improved cell stability, low-temperature data retention and radiation tolerance over our competitors' 4-T designs.
- Low-power CMOS benefits, including 100/250$\mu$A standby current (ICCSB)
- High speed: 150 ns access time
- Packaged in 28-pin ceramic DIP or 32-pad leadless chip carrier (LCC)

Our HM-65642 is bred for reliable performance in your toughest micro-based systems...in missiles, field-deployed PBXs, guidance systems, aircraft computers. Available soon in a military drawing.

To build more reliable systems, start with our HM-65642. For samples or a data sheet, contact: Harris / MHS Semiconductor Sales Ltd., Eskdale Road, Winnersh, Wokingham, Berks, RG11 5TR, England.


FOR YOUR INFORMATION, OUR NAME IS

# HARRIS

Harris Semiconductor: Analog - CMOS Digital
Gallium Arsenide - Semicustom - Custom

HARRIS


CIRCLE NO 114

# Memory-mapped coprocessor speeds floating-point math

*By using a memory-mapped, low-latency coprocessor in your general-purpose computer design, you can accelerate the machine's floating-point calculations dramatically while maintaining software compatibility with off-the-shelf compilers.*

Mauro Bonomi and Christopher Tice,
*Weitek Corp*

Increasing the speed of floating-point calculations in the 32-bit computer systems you design can save a lot of CPU time. Merely adding a standard coprocessor, however, is not always the optimal solution for such systems. For one thing, although standard coprocessors such as the 68881 cost relatively little and are compatible with off-the-shelf compilers, they often have limited floating-point math speeds. Further, coprocessors that operate at very high speeds (such as those based on the WTL 1164/65 multiplier/ALU set) are not compatible with standard compilers, and they've traditionally been expensive to implement.

An alternative to using one of these low-end or high-end coprocessors with your CPU is to use a chip set such as the WTL 1167, which adds a floating-point interface controller (the WTL 1163) and some associate interface chips to the WTL 1164 floating-point multiplier and WTL 1165 arithmetic logic unit (ALU). The chip set allows a computer to perform floating-point math operations at a much faster rate than it can achieve with standard numeric processors, and it is supported by standard high-level-language compilers (see **box,** "Compilers for the 1167").

The 1167 accelerates floating-point operations in three ways: It uses low-latency, 64-bit data paths for the floating-point operations performed by the multiplier and ALU; it provides memory mapping, which allows it to acquire data and instructions by using both the address bus and the data bus simultaneously; and it overlaps instructions.

The 1164/1165 multiplier and ALU use dedicated circuit arrays to perform the required functions, providing significantly faster processing than coprocessors that rely on sequential, clocked logic. The array's flow-through time for the 1164 is under 240 nsec for a single-precision (32-bit) multiply and under 360 nsec for a double-precision (64-bit) multiply. For the 1165, the array's flow-through time is under 240 nsec for both single- and double-precision functions.

All data transfers to and from the floating-point math chips take place over a 32-bit data bus. Bus transceivers isolate the floating-point subsystem from the 80386 data bus. The transceivers are enabled only when a data transfer between the coprocessor and the 80386 occurs.

### Design a memory-mapped interface

**Fig 1** shows a typical design of a memory-mapped coprocessor interface, including the 1167 coprocessor and the system's CPU (an Intel 80386 μP). **Fig 2** shows a standard implementation: A 4½×5-in. daughter board that holds the 1167 plugs into the extended-math-coprocessor socket (a superset of the 80387 socket) on an 80386 mother board.

The internal architecture of the 1163 allows for memory mapping **(Fig 3)**. The 1163 has thirty-one 32-bit data registers, which can store coefficients, operands,

*Memory-mapped coprocessors accelerate floating-point math by allowing for 64-bit data paths, memory mapping, and instruction overlapping.*

and intermediate results. This configuration minimizes the number of data transfers between the 80386 and the coprocessor when the system is performing multiple operations. Instructions are sent to the 1163 over the same address bus that connects the main memory to the CPU. The system data bus is used only to exchange data between the CPU and the coprocessor. By using both the address bus and the data bus, you can use just one CPU instruction to specify the operation desired, specify the operands' sources and destination, and pass 32-bit data to the coprocessor.

The 14 least significant address bits ($A_{15\text{-}2}$), along with three of the four byte enables ($BE_{2\text{-}0}$), define the CPU instructions. The three byte-enable bits are de-

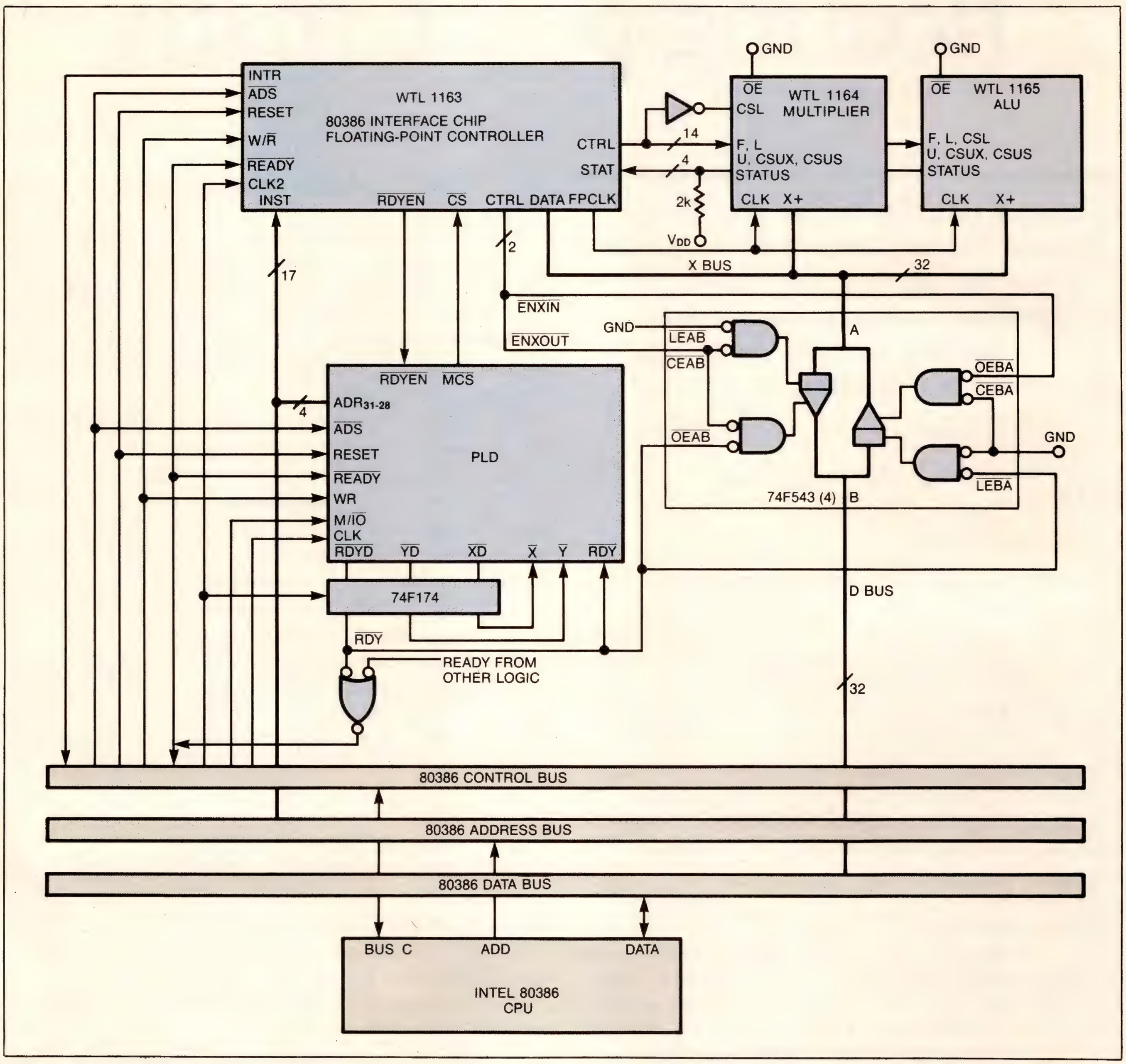



***Fig 1—The interface between an 1167 memory-mapped coprocessor*** *and an 80386-based system includes an external PLD. You can locate the coprocessor anywhere in the system's memory map by modifying the address decoder in the external PLD.*

coded to a 2-bit byte address, which is combined with the least significant address bits to form a 16-bit instruction word. The 1167 therefore occupies $2^{16}$ bytes, or 64k bytes, of the 80386's 4G-byte address space. This 16-bit field is divided into a 6-bit opcode and two 5-bit operand fields, SRC1 and SRC2/DEST (**Fig 4**). SRC1 specifies either a general-purpose register in the 80386 or one of the data registers in the 1163. SRC2/DEST always specifies an 1163 data register.

Instructions are latched in the instruction register located in the 1163. The 1163's decoder then decodes the 6-bit opcode and points to the microcode that executes the instruction by controlling the operation of the 1164/1165 and the transceivers.

As you can see from **Fig 1,** the memory-mapped coprocessor interface includes a programmable logic device (PLD). You need to define an external PLD to perform address decoding so that you can locate the coprocessor anywhere in the system's memory map. The PLD and the 1163 sample the bus states on the 80386 system bus, allowing both pipelined and nonpipelined addressing. The PLD generates the handshake between the coprocessor and the CPU via the Ready line. If the coprocessor is busy and can't accept a new instruction, the Ready line is held false. The CPU automatically inserts wait states and completes the bus transaction only when the coprocessor is ready to accept the new instruction. The transfer latency to and from the 1167 coprocessor is transparent to system and application software.

The PLD generates the chip-select signal for the 1163 by decoding the upper address bits of the system address. In the state diagram **(Fig 5)**, the variable "SEL1163" is the decoded signal, which indicates that a bus cycle for the 1163 is in progress. The boxes labeled "ADS" and "WR" in the state diagram represent system-control bus signals. The PLD uses the RDYEN signal from the 1163 to determine whether the coprocessor is ready to accept another instruction, or, in the

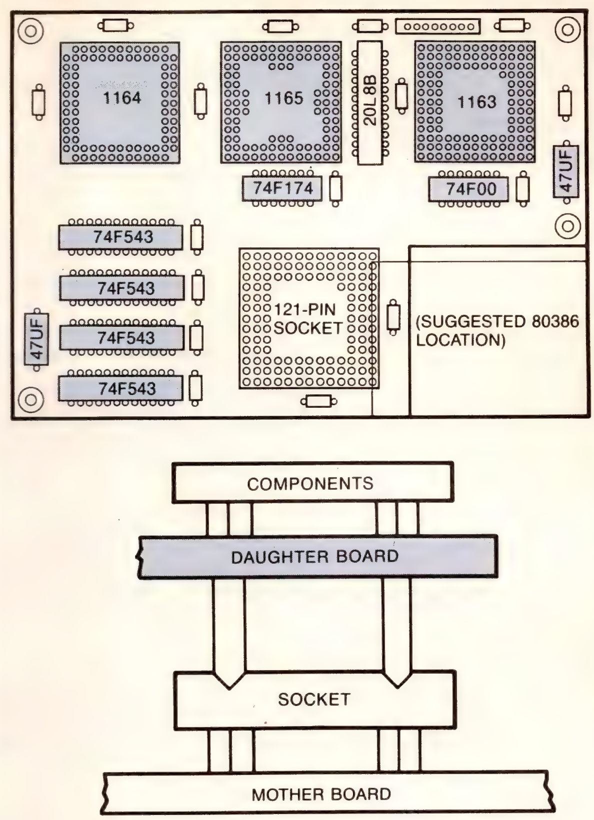



***Fig 2—The daughter board carrying the 1167*** *includes an extended-math-coprocessor socket (a 121-pin PGA socket) that is a superset of the socket for the 80387 coprocessor.*

## Compilers for the 1167

A number of independent software vendors (including Green Hills, Silicon Valley Software, and Metaware) offer Pascal, Fortran, and C compilers for the Intel 80386 that are compatible with the 1167 floating-point chip set. These compilers let you use software to select the 80387 or 1167 at compile time.

Independent software vendors that port their packages to 386-based systems can recompile their floating-point-intensive packages for the 1167. Standard engineering packages run two to three times faster when recompiled and run in systems with an 1167 memory-mapped coprocessor.

The compiled code is still compatible with target systems that don't incorporate the memory-mapped coprocessors, as long as their operating systems support the 1167 coprocessor. The new operating system for the 80386—Unix System V/386 from Interactive Systems—can emulate the 1167. If the 1167 coprocessor is not in the system, and an 1167 floating-point instruction is specified by the program, a trap is activated and the operating system calls a software subroutine that executes the instruction. With all the proper software tools, the end user will be able to take advantage of the 1167's performance without having to make any special software-development effort.

*You need to define an external PLD to perform address decoding so that you can locate the coprocessor anywhere in the system's memory map.*

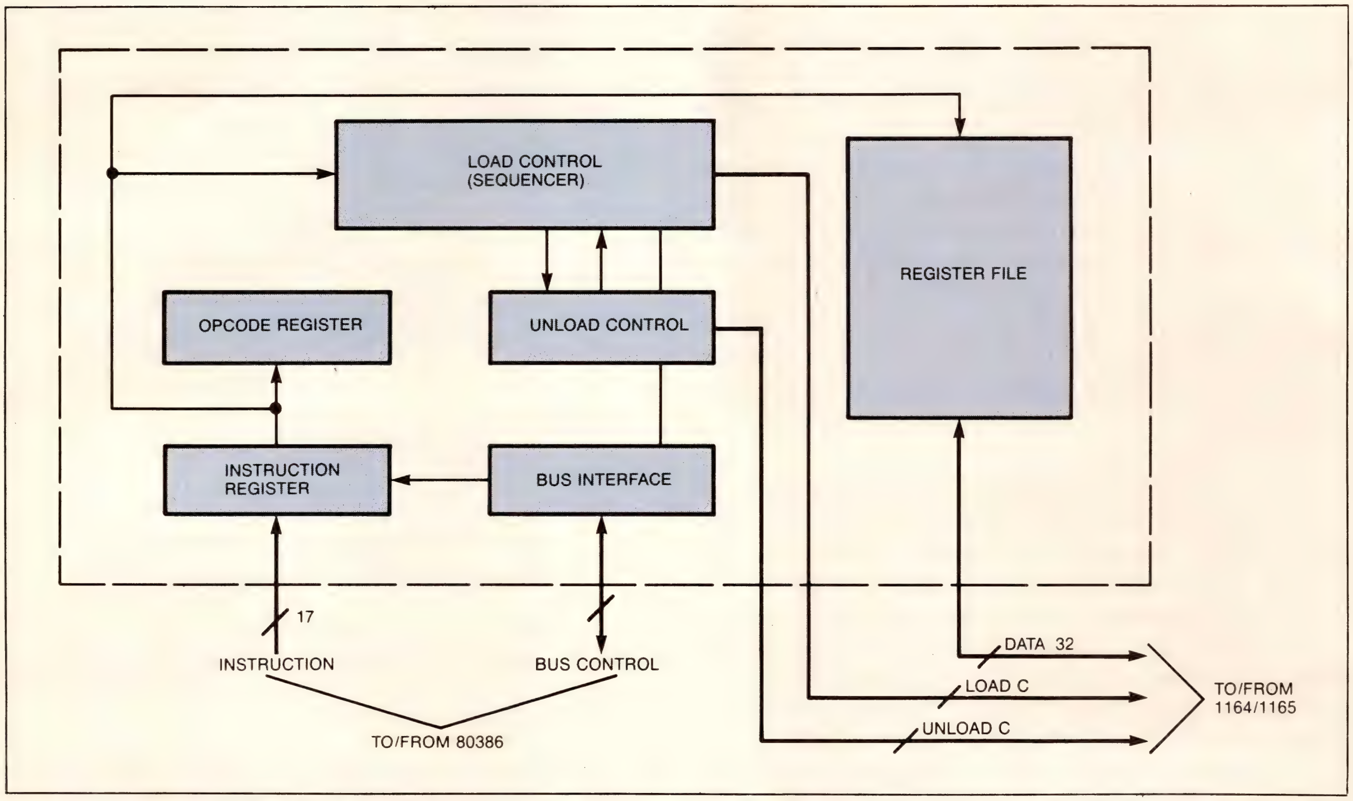



**Fig 3—Besides incorporating an internal sequencer and control circuitry,** *the 1163 memory-mapped coprocessor-interface chip has a 31×32-bit register file, which can store coefficients, operands, and intermediate results. This configuration minimizes the number of data transfers between the 80386 and the coprocessor when the system is performing multiple operations.*

case of reads, whether data is available. In the case of writes, which are used to load data and initiate floating-point instructions, the PLD makes the transition from state A to state C and signals "Ready" to the 80386. For this transition, the PLD samples RDYEN to determine whether the coprocessor can accept another instruction.

For reads that are used to store data from the coprocessor, the PLD acts as a variable wait-state generator, inserting wait states until the data is available. Similarly, if the coprocessor is busy when a new floating-point instruction is broadcast, the PLD generates wait states until the coprocessor is ready to accept the new instruction. Once the 1163 acknowledges the transfer with the RDYEN signal, the PLD makes the transition from state B to state C and signals "Ready" to the 80386. States D and E monitor bus cycles and pipelined bus states to other memory-mapped peripherals.

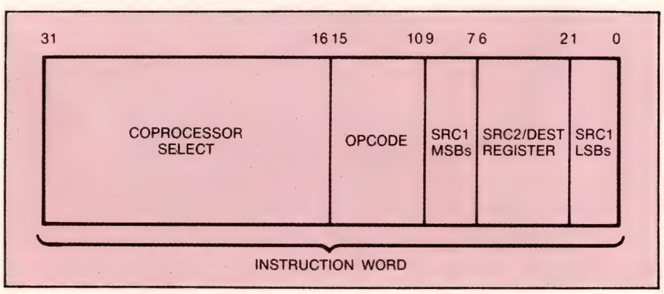



**Fig 4—A 16-bit instruction word** *controls the operation of the 1167 coprocessor. This 16-bit field is divided into a 6-bit opcode and two 5-bit operand fields, SRC1 and SRC2/DEST.*

### Interface chip overlaps instructions

Besides providing memory mapping, the 1163 performs instruction overlapping. **Fig 6a** illustrates the serial execution of a standard (nonoverlapping) coprocessor: The μP fetches the operands from memory and passes them, with one instruction, to the coprocessor. The coprocessor then executes the instruction and passes the results to the μP. Only then can the μP pass another instruction and more operands to the coprocessor. The μP can perform other tasks while it waits for the coprocessor to finish a computation, but the coprocessor can execute only one instruction at a time.

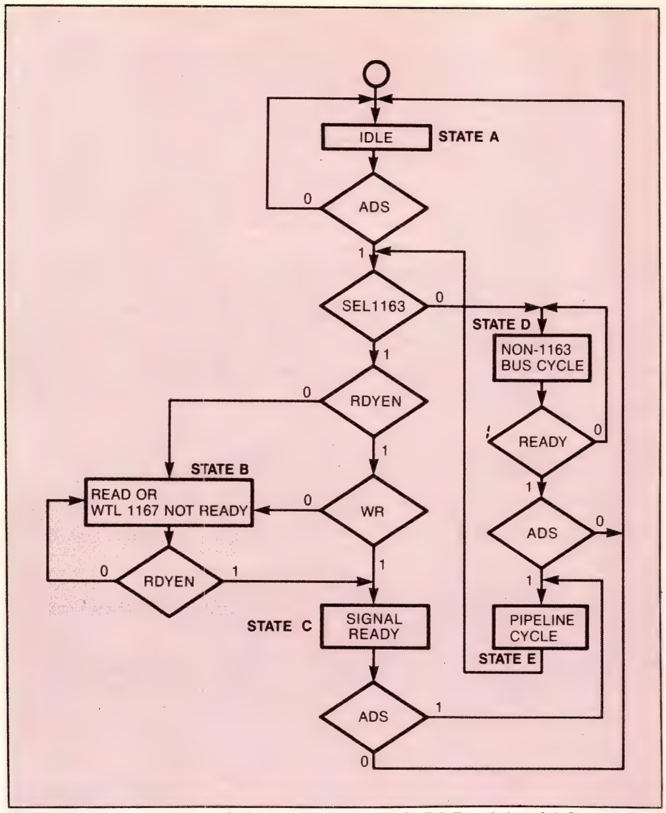



*Fig 5—You need to define an external PLD, for which a state-transition diagram is shown here, to perform address decoding so that you can locate the 1167 coprocessor anywhere in your system's memory map, and to complete the bus interface.*

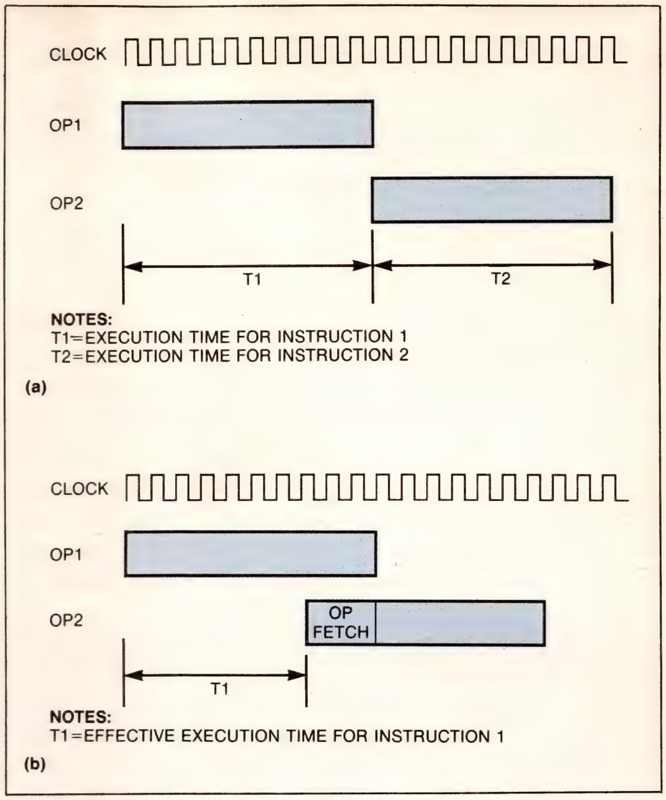



***Fig 6—Standard coprocessors don't allow instruction overlapping (a):** The CPU must transfer each operand and instruction serially to the coprocessor and get the result before transferring the next set of operands and instructions. Memory-mapped coprocessors, however, overlap operand fetching with the end of the previous instruction's execution **(b)**.*

**Fig 6b** shows how the 1163 overlaps floating-point instructions. Note that it's only the execution of one instruction and the fetching of the next instruction's operands that are overlapped. Overlapping further decreases the latency of floating-point instructions when a stream of operations is executed.

To see some of the details of how a memory-mapped, low-latency coprocessor performs overlapping, consider a simple series of multiply/accumulate (MAC) instructions. Such instructions are common in applications such as graphics transformations, in which 16 multiplications and 12 additions are needed to transform each pixel. The 1167 chip set provides a MAC instruction, which allows the CPU to specify both a multiplication and an addition with a single instruction.

This example assumes that the 80386 host has previously transferred the operands needed for the MACs to the coprocessor. The operands all reside in the register file in the 1163. **Fig 7** lists the steps involved in the execution of a string of MAC instructions. In each of these instructions, every step requires one clock cycle (assuming the clock is identical to the one that drives the 80386).

In the first instruction, the first processing step is to fetch the first operand from the register file. In the next two cycles, the interface transfers this operand to the 1164 multiplier and fetches the second operand from the register file. The interface then transfers the second operand to the 1164 and tells the 1164 to multiply the two operands. The interface then waits three cycles while the 1164 is performing the operation. In the eighth cycle, the 1163 tells the 1164 to transfer the result back and then waits one cycle for the 1164 to comply. The interface gets the results in the tenth cycle and stores them in the register file in the eleventh.

The addition half of the MAC proceeds just as the multiplication did, except for two differences: The interface deals with the 1165 ALU instead of the 1164 multiplier, and, more important, some steps of the addition overlap those of the multiplication. Register R2 is always used, in a MAC instruction, as a source and destination register. During the cycle in which the interface tells the 1164 to transfer the multiplication result back to the register file, the interface can also fetch R2. Then, while the interface is waiting to get the result from the 1164, the 1163 can send the contents of R2 to the 1165. Because the result of the multiplication is the second operand of the addition, the interface loads the multiplication result directly into the 1165 on the ninth cycle.

This overlapping scheme saves the floating-point subsystem a significant amount of execution time. The multiplication still takes the full 11 cycles, but the subsequent addition takes only six additional cycles to complete. The following multiplication overlaps with the addition operation, taking only seven more cycles to complete. So a single-precision MAC operation is then completed every 13 cycles. Without the overlapping

*For reads that are used to store data from the coprocessor, the PLD acts as a variable wait-state generator, inserting wait states until the data is available.*

scheme, each single-precision MAC operation would take 20 cycles to execute.

Note that although the 1164 and 1165 operate in accordance with the IEEE floating-point format, the 1167 memory-mapped coprocessor doesn't provide all of the features defined by the IEEE standard. For example, like other high-speed coprocessors, the 1167 generally treats denormalized numbers (the very small numbers that can't be represented in the normal format) as zero, because few applications require the level of accuracy represented by these small numbers. (This mode of operation, known as Fast Mode, is commonly used in high-performance systems such as those from Cray and DEC.)

### Overlapping makes exception handling difficult

The 1167 also makes exceptions (such as underflow, overflow, and inexact) more difficult to handle. The

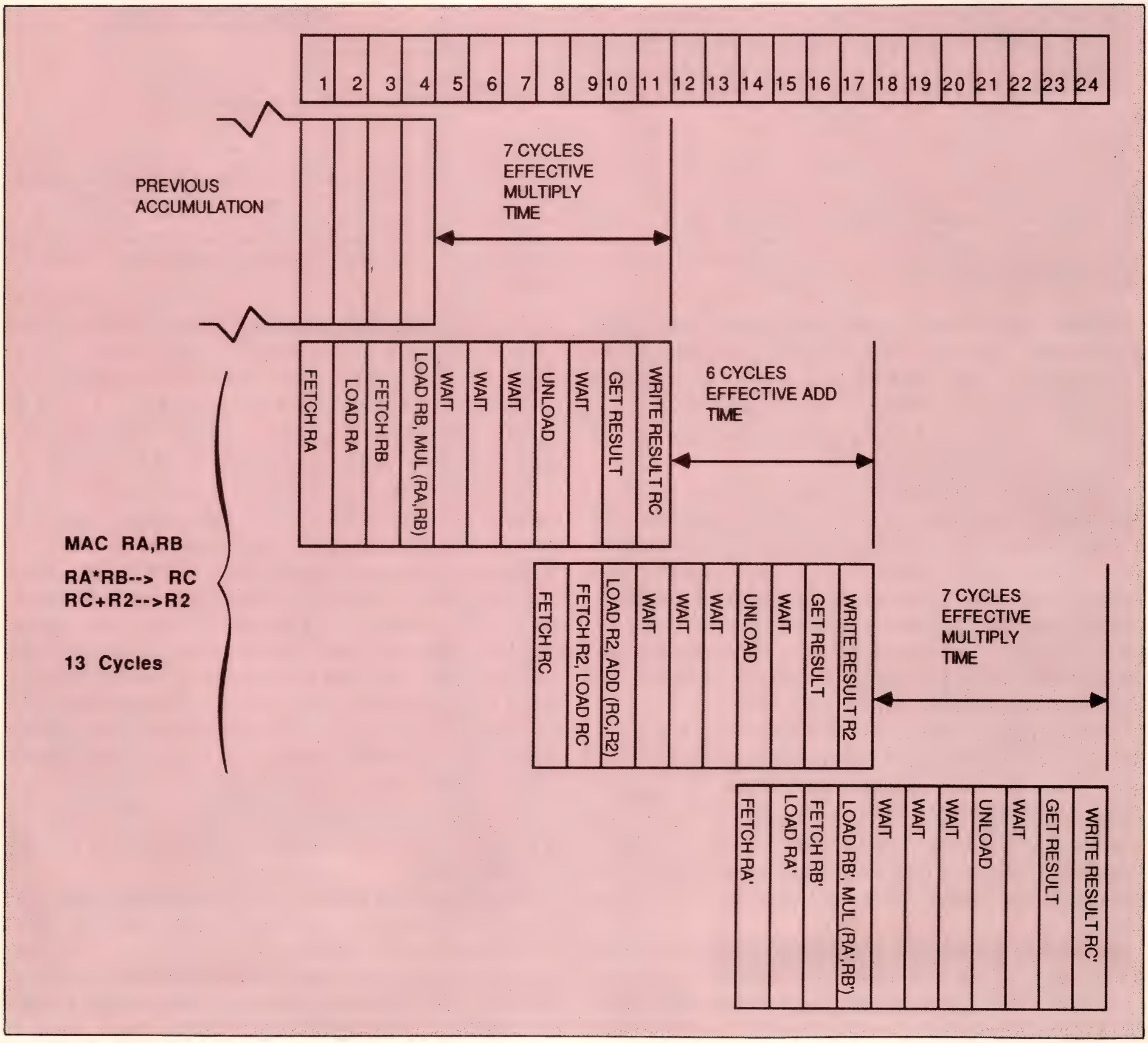



***Fig 7—The execution sequence for a series of*** *1167 multiply/accumulate instructions shows how instruction overlapping saves CPU time. The effective time for the operation is reduced to 13 cycles.*

1167 detects exceptions and accumulates them in a status field register. It flags each exception and sends an interrupt to the CPU. The CPU acknowledges by reading the exception register to identify the exception. However, because of the overlapping process, it's difficult for the CPU to identify exactly which instruction caused a particular exception.

To see how exception handling works in a low-latency coprocessor such as the 1167, consider this coprocessor instruction sequence:

1) ADD RN, RN+1
2) MUL RK, RK+1
3) ADD RM, RM+1
4) ...

Suppose the CPU sends instruction 1 to the coprocessor. The coprocessor accepts the instruction, and after the transfer is completed, the coprocessor sends an acknowledge indication to the CPU to send a new instruction. The CPU immediately sends instruction 2 to the coprocessor. As soon as the coprocessor completes the data fetching for instruction 1, it accepts instruction 2 and issues another acknowledge to the CPU for a new instruction. The CPU begins transferring instruction 3. At this point, the CPU has sent two instructions, is transmitting a third one, and is waiting for the coprocessor to acknowledge this last one. If the coprocessor flags an exception at this point, the CPU has no way of knowing whether instruction 1 or instruction 2 caused the exception.

You can quickly identify the instruction that caused the exception by examining the assembly code. If the exception was an underflow, for example, and you find a division instruction among those that were executing at the time of the exception, you can be fairly sure that the division instruction is the culprit. By identifying the exception's source, you can fix it for subsequent runs of the program. You can't recover from an exception during program execution, however, because the CPU can't trap on the troublesome instruction.

Fortunately, exceptions generally occur only during program design. In the debugging stage of program design, you can identify the instruction that caused the exception by reading the exceptions register after every floating-point instruction and then testing the exception bit. Once you've worked the bugs out of a program, any remaining exceptions are usually the result of improper initial data values.

With an 1167 coprocessor, an 80386 μP can achieve two to three times the performance of a VAX 11/780 with a floating-point accelerator (FPA). In a 4×4 matrix multiplication (an operation typical of graphics transformations), an 80386 with an 1167 processed more than 60,000 vectors/sec and transformed 1k points, using a Radix 2 butterfly algorithm, in 35 msec.

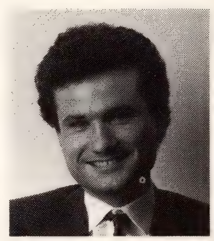
**TABLE 1—FLOATING-POINT-OPERATION PERFORMANCE BENCHMARKS**

| | LINPACK (SP) M FLOPS | WHETSTONE (M WHETSTONES) |
|---|---|---|
| INTEL 386 WITH WTL 1167* | 0.80 | 4.6 |
| VAX 11/780 WITH FLOATING-POINT ACCELERATOR | 0.23 | 1.2 |
| VAX 8600 | 0.61 | 5.5 |
| 68020 WITH A 68881* | 0.11 | 1.1 |

*20-MHz VERSION

**Table 1** compares some performance figures obtained for an 80386 with an 1167 coprocessor with figures for other industry-standard coprocessors. A system with a 20-MHz 80386 and an 1167, for example, obtained 4.6M Whetstones on the Whetstone benchmark; that measurement is more than three times the measurement obtained from a VAX 11/780 minicomputer with a floating-point accelerator. **EDN**

## Authors' biographies

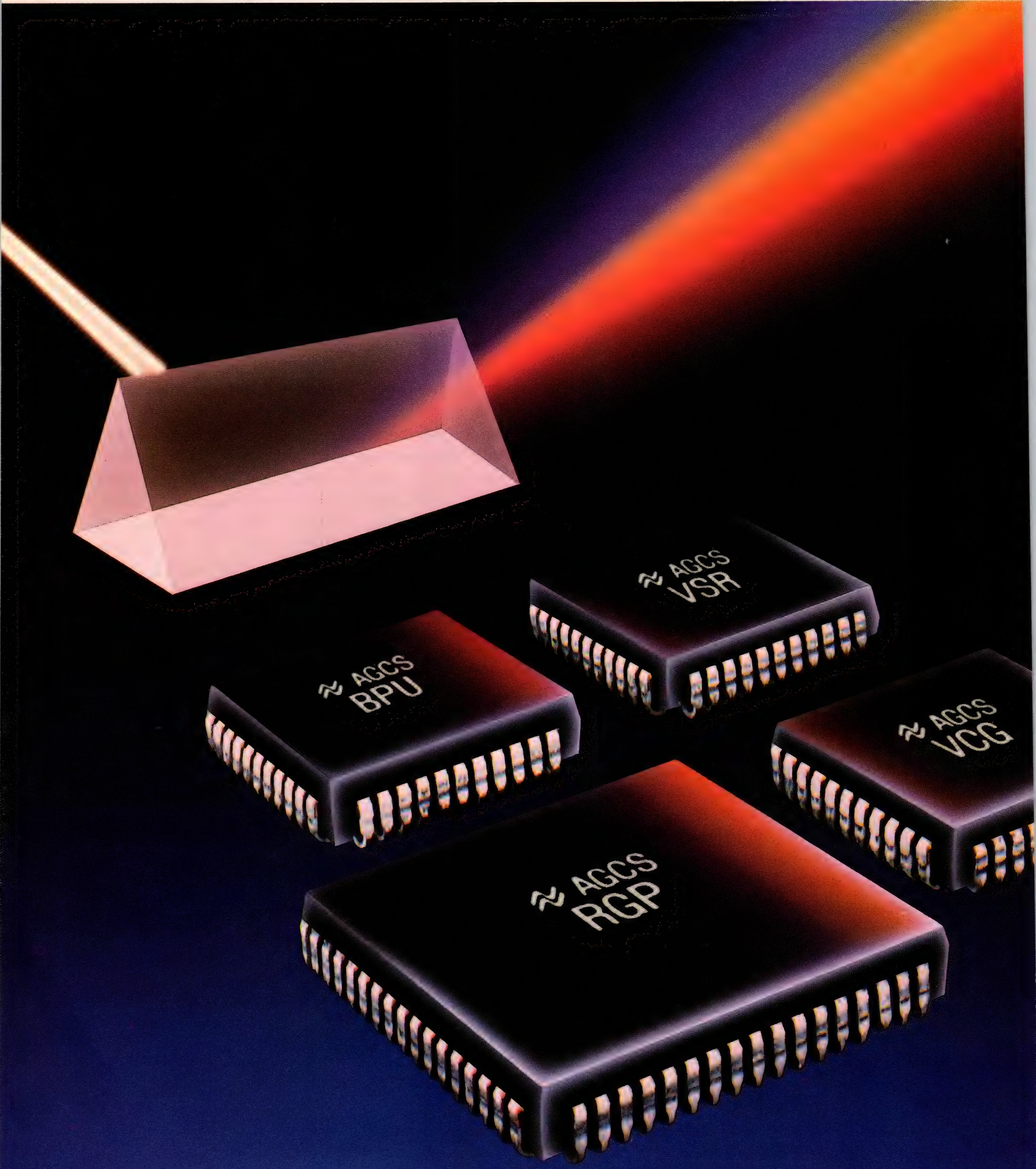


*Mauro Bonomi is a product manager at Weitek Corp (Sunnyvale CA), where he defines marketing strategies for the company's floating-point coprocessor products. He was previously employed at Raychem Corp. Mauro holds a degree in electrical engineering from Pavia University, Italy, and both an MSEE and an MS in management from Stanford University. In his spare time, he enjoys skiing, golf, tennis, and sailing.*

*Christopher Tice is senior design consultant at Weitek Corp; he acts as systems design consultant and provides technical support for the company's products. He worked on the design team that developed the WTL 1163. Chris was previously employed at Harris Corp's Computer Systems Div. He received a BSEE from the University of Florida and is a member of the IEEE Computer Society. His leisure pursuits include skiing, scuba diving, and tennis.*

**Article Interest Quotient (Circle One)**
**High 476 Medium 477 Low 478**

National Semiconductor




Advanced Peripherals

# Finally, graphics to match your imagination.

## INTRODUCING THE FIRST EFFECTIVELY PARTITIONED VLSI ARCHITECTURE FOR TRULY FLEXIBLE GRAPHICS SYSTEMS DESIGN

Imagine a graphics architecture so powerful, you can achieve 16K-by-16K resolution. So effective, you can add virtually unlimited planes of color without degrading performance. So flexible, you can integrate it into an existing design or use it to build an entire range of new systems.

That's the Advanced Graphics Chip Set from National Semiconductor.

By using a multiple-chip, modular approach, the Advanced Graphics Chip Set avoids the design compromises and limitations of single chip solutions.

That gives you two unprecedented benefits: *performance* and *flexibility*.

Which means you can design exactly the type of system you need with exactly the level of performance your application demands.

For example, you can integrate part of the chip set with an existing general-purpose microprocessor for a low-end display.

Or you can utilize the chip set's full capabilities for a high-end, high-performance, high-resolution CAE/CAD workstation or laser printer — with virtually unlimited planes of color. Yet with the same high-speed performance as a black-and-white application.

In fact, you can design an entire range of graphics systems without having to "reinvent the wheel" each time, by using the same hardware building blocks and the same central software in each of the systems.

### THE ADVANCED GRAPHICS CHIP SET

**Raster Graphics Processor (RGP).** A fully programmable, high-performance microprocessor engine specially tuned for graphics applications.

**Bitblt Processing Unit (BPU).** A 20-MHz data chip that controls data movements within its dedicated memory plane and between it and other memory planes in a multi-color system. Available now.

**Video Clock Generator (VCG).** A timing and control generator providing all of the synchronization signals needed by a graphics system, with a pin-programmable pixel frequency of up to 225 MHz. Available now.

**Video Shift Register (VSR).** A parallel-to-serial shift register capable of serial output shift rates up to 225 MHz. Available now.

*All devices available in PLCCs.*

## THE MULTIPLE-CHIP SECRET

The secret to all this flexibility and performance is our unique multiple-chip, modular approach. Rather than trying to squeeze all the important graphics functions onto a single chip — which would require some significant design and performance compromises — we've partitioned appropriate functions onto individual building-block ICs. This allows us to optimize the design of each chip, and allows you to optimize your own design for your particular application.

## GRAPHICS WITHOUT LIMITS

What matters most about the Advanced Graphics Chip Set, of course, is what it does for *you*. And that answer is clear when you consider its high performance, its modular approach, its open architecture, and its programmability: It gives you graphics without limits. It gives you true design freedom. It gives you the opportunity, for the first time, to design a graphics system "custom fit" to your exact specifications.

So what are you waiting for? If you're tired of those limited single-chip solutions bogging down your designs, take a look at the Advanced Graphics Chip Set. And learn how you can design a graphics system to match your needs . . . as well as your imagination.

For more information and availabilities, just contact your local National Semiconductor Sales Engineer or write:

National Semiconductor
Advanced Graphics, MS 23-200
P.O. Box 58090
Santa Clara, CA 95052-8090

National Semiconductor



CIRCLE NO 113

# World's largest sele

*Introducing twelve new CMOS FIFOs □ the biggest FIFC*

### *The world's largest, fastest family of FIFOs provides flexible system architecture.*

IDT has the FIFO you need for any high-speed application:

**Big FIFOs.** Use our 256, 512, 1K, 2K or 4Kx9 FIFOs to build larger memory buffers for data storage or networking applications. Using these large FIFOs, you can build incredibly dense buffers without resorting to cascading a multitude of smaller FIFOs which eat up valuable board space and slow down your design.

**Small FIFOs.** Use our 64x4 & 64x5 FIFOs to build small buffers for a high-speed, tightly coupled computational engine.

**Specialty FIFOs.** Use our serial/parallel FIFOs for superb data handling flexibility.

**Raw speed.** All of our FIFOs are the fastest available today and will become even faster in the coming months. Our winning CEMOS™ technology puts you ahead today and tomorrow.

**Architectural speed.** All of our FIFOs are built with a dual-ported RAM array that gives you zero fall-through time.

**Flexible system architecture.** Thanks to innovative features like multiple flags and serial shifters.

### *Introducing the world's largest and fastest serial/parallel FIFOs.*

The IDT72104 4Kx9 and IDT72103 2Kx9 FIFOs will compact your serial interface by allowing you to perform serial-to-parallel, parallel-to-serial, serial-to-serial and parallel-to-parallel operations without any external circuitry.

Fast 50ns parallel port access time and 40MHz serial input/output rate.

Flexishift™* logic allows you to set serial word widths to be anything from 4 bits wide to as wide as you need.

Separate serial input/output clocks for true asynchronous operation.

Simple depth and width expansion in both serial and parallel modes without any additional logic.

Six status flags, including almost full and empty, indicate well in advance how much data is available—thus giving your system plenty of time to react.

The read retransmit capability enables you to resend data—a useful feature for telecommunications and digital filter applications.

These FIFOs give you superb data handling flexibility for serial-parallel data transfer applications such as digitized video and audio, high-speed data links, high-density media storage and local area networks.

Available in 40-pin DIPs and 44-pin LCCs and PLCCs.

### *Introducing the world's first 4Kx9 and 2Kx9 CMOS FIFOs.*

The IDT7204 50ns (access time) 4Kx9 and IDT7203 50ns 2Kx9 are the world's largest FIFOs. Both are pin and functionally compatible with the IDT7202 35ns 1Kx9, the IDT7201 35ns 512x9 and MK4501 512x9 FIFOs. □ asynchronous and simultaneous read/write—can buffer any data rate, with or without system clock □ empty, full and half-full flags □ easily expandable—built-in hooks to make deeper and wider FIFOs without external logic □ retransmit capability in single device mode □ 28-pin DIP and 32-pin LCC and PLCC.

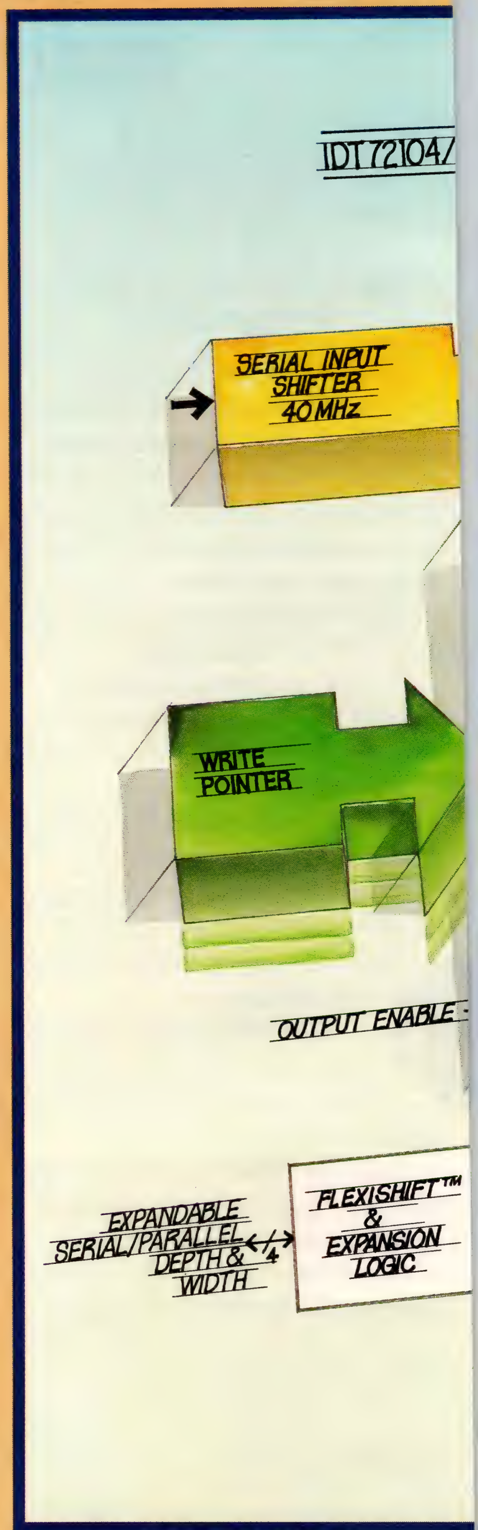
### *Introducing the world's fastest CMOS 64x4/5 FIFOs.*

IDT72401/02/03/04 and IDT72413 operate at shift rates up to 35MHz. □ low power CMOS operates at 1/4 bipolar power □ zero fall-through time RAM array.

### *High-density FIFO modules.*

We also surface mount four IDT7203 or IDT7204 FIFOs, packaged in LCCs, on a co-fired multilayered ceramic DIP substrate. The result is two extraordinarily dense, fast, rugged, low-power FIFO modules: IDT7M206 16Kx9 and IDT7M205 8Kx9.


***May we be of assistance?*** Call your local IDT representative or **1-800-IDT-CMOS**. Ask for a copy of our *Application Note*—explaining how to use deep, fast FIFOs—and a *Product Selector Guide* on high-speed CEMOS products.

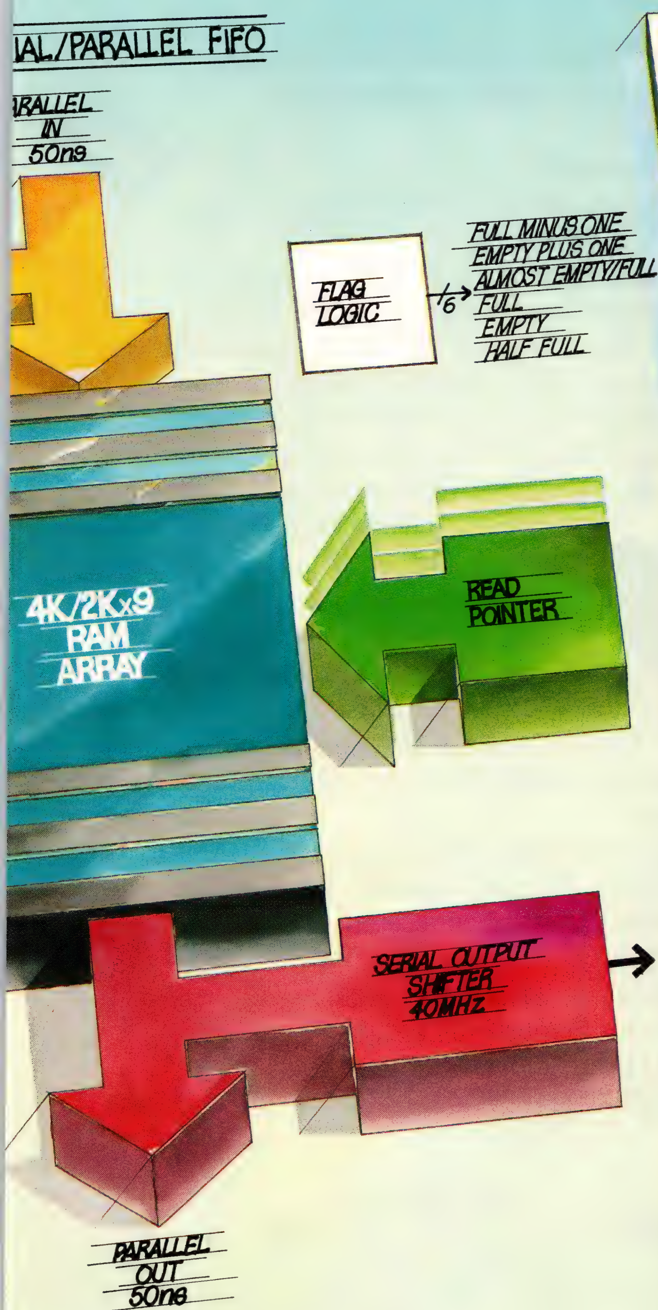



*CEMOS and Flexishift are trademarks of Integrated Device Technology, Inc. *Patent pending.*

Integrated Device Technology
3236 Scott Boulevard, Santa Clara, CA 95054-3090
(408) 727-6116 TWX: 910-338-2070

# ion of fast FIFOs.

*the fastest big FIFOs □ the fastest small CMOS FIFOs □ the only parallel/serial FIFOs.*




**WORLD'S DENSEST FAST FIFO's**

| | PART TYPE | IDT | |
|---|---|---|---|
| 256x9 | 7200 | Coming 4Q87 | Half full flag. Full read retransmit capability and zero fall-through time |
| 512x9 | 7201△ | 35ns | |
| 1Kx9 | 7202△ | 35ns | |
| 2Kx9 | 7203 | 50ns | |
| 4Kx9 World's Densest fast FIFO | 7204 | 50ns | |
| 8Kx9 Module | 7M205 | 55ns | |
| 16Kx9 Module | 7M206 | 55ns | |
| 2Kx9 Serial/Parallel | 72103 | 50ns | New flags: Almost empty/full Empty plus one Full minus one |
| 4Kx9 Serial/Parallel | 72104 | 50ns | |

**WORLD'S FASTEST SMALL FIFO'S**

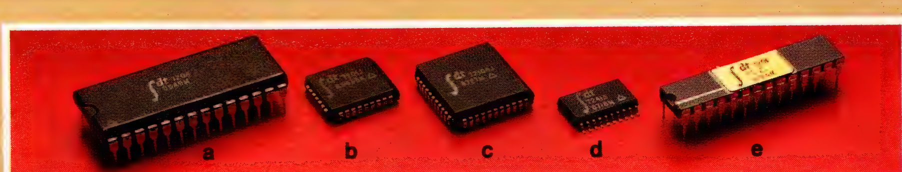
| | IDT PART NO. | IDT CMOS | MMI BIPOLAR | Cypress CMOS |
|---|---|---|---|---|
| 64x4 MMI67401 Compatible | 72401* | 35MHz** | 16.7MHz | 15MHz |
| 64x5 MMI67402 Compatible | 72402* | 35MHz** | 16.7MHz | 15MHz |
| 64x4 CY7C403 Compatible | 72403* | 35MHz** | | 25MHz |
| 64x5 CY7C404 Compatible | 72404* | 35MHz** | | 25MHz |
| 64x5 MMI67413 Compatible | 72413* | 35MHz** | 35MHz | |

△Now available in 300 mil space saving THIN SIDEBRAZE for IDT7201/02

* These IDT parts available in compact gull-wing SOIC, Hermetic DIP, LCC and plastic DIP packages

**45 MHz devices available 4Q87

***Standard DIP packages:***
(a) 28-pin, 600 mil wide plastic DIP
***Surface mount packages:***
) 32-pin PLCC (c) 44-pin PLCC (d) 20-pin SOIC
***Space saving packages:***
(e) 28-pin, 300-mil wide Sidebraze THINDIP




**CIRCLE NO 139**

# SONY SETS NEW RECORDS IN SRAM PERFORMANCE.

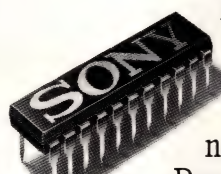

To help your designs push the limits of high-speed performance, design in Sony's high-speed SRAMs.


Because our SRAMs, featuring full-CMOS technology, offer perhaps the fastest access times of any SRAMs available.

Speeds of up to 25 ns in 64K configurations. 25 ns in 72K configurations. And 45 ns in 256K configurations.

Plus with our state-of-the-art one-micron CMOS technology, all Sony SRAMs incorporate 6-transistor storage cells. So you'll benefit from very low data retention current, too. Lower than 500 nanoamps at room temperature.

Our 64K and 72K SRAMs are available in 300-mil DIP packages. And our 256K SRAMs in either 600-mil DIP or 32-pin LCC packages.

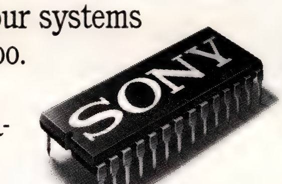



And we're not just talking engineering samples here. Because right now, our SRAMs are in full production. Ready for immediate delivery.

Plus of course, like with any Sony product, you're also assured the utmost in quality, reliability and performance.

So put Sony's high-speed, full-CMOS SRAMs to work in your designs. Then who knows? Your systems may set some performance records, too.

To get all the details, call (714) 229-4192 today. Or write Sony Corporation of America, Component Products Group, 10833 Valley View St., Cypress, CA 90630. FAX (714) 229-4271.

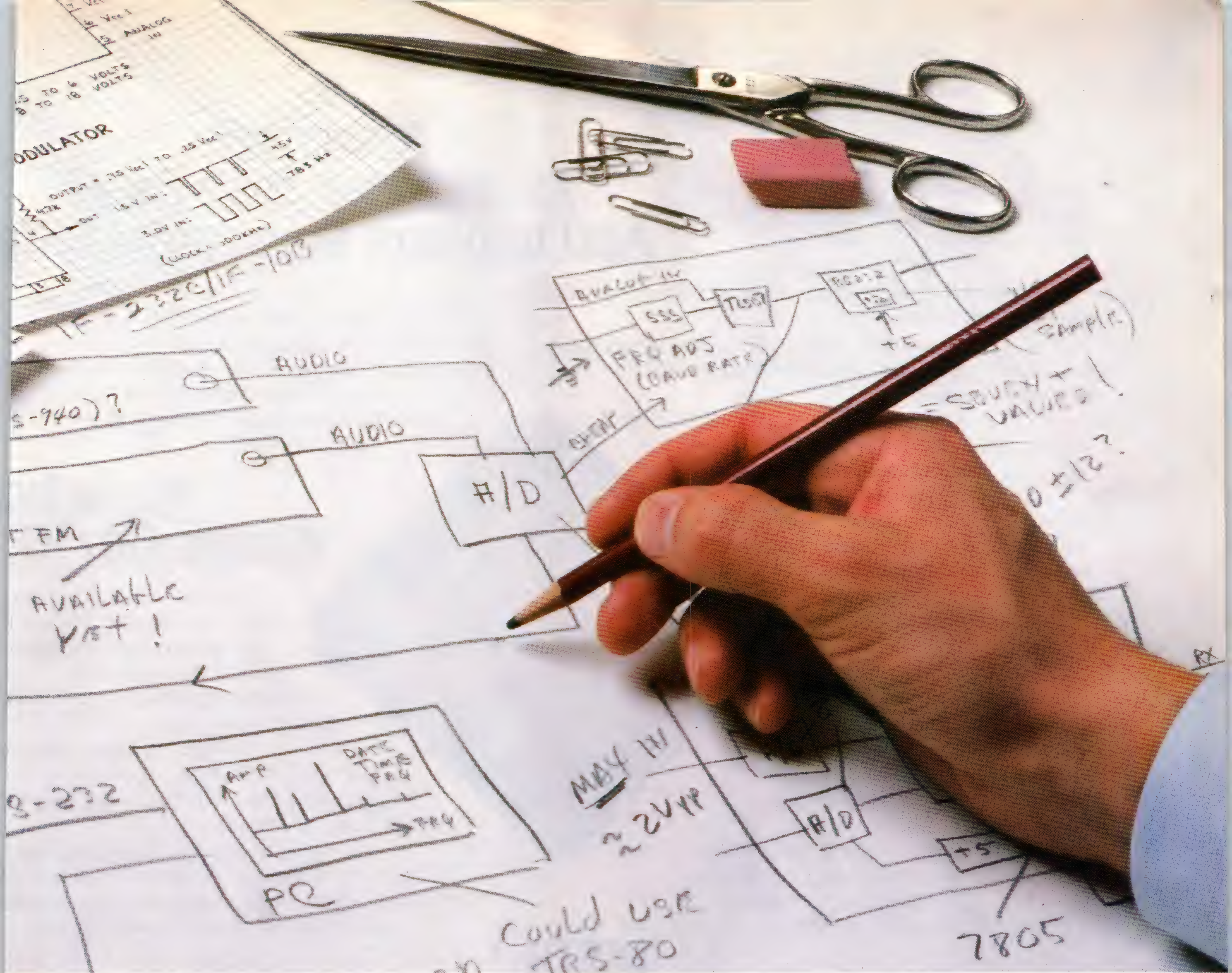



**SONY SRAM DEVICES**

| PART NUMBER—PACKAGE | DENSITY | ORGANIZATION | SPEED (ns) |
|---|---|---|---|
| CXK5863P—25/30/35 300 mil DIP | 64K | 8K x 8 | 25/30/35 |
| CXK5971P—25/30/35 300 mil DIP | 72K | 8K x 9 | 25/30/35 |
| CXK58255P—45/55 600 mil DIP | 256K | 32K x 8 | 45/55 |
| CXK58255K—45/55 32 pin LCC | 256K | 32K x 8 | 45/55 |

SONY®

CIRCLE NO 138




# VideoLog gives you more time to do what you do best.

If you're an engineer, it can take you a half day, or more, to hunt through a mountain of data books and catalogs for the components you need. And even then, there's no guarantee that what you find is the best solution to your problem.

Now there's a better way to locate components. VideoLog.

From an enormous online database, covering a broad spectrum of over 650,000 commercial and military semiconductors and other products, you can find what you need in an average of 15 minutes. You can locate a new component, or an alternate source. You'll find out who makes it, what it costs, and where you can get it. You'll also know if the device is still current, or if a replacement exists.

VideoLog is fast, convenient, it keeps you abreast of new product news and industry developments. But, most importantly, it gives you more time to do the things you do best.

**VideoLog®**
**It's there when you need it.**

VideoLog Communications, 50 Washington Street, Norwalk, CT. 06854

For more information, call

## 1-800-VIDEOLOG

(1-800-843-3656). In Conn.: (203) 838-5100.
Or use the coupon below.

### Free Online Demo:

Dial 1-800-VIDPEEK, (1-800-843-7335) with any ASCII (80 col.) terminal and 300 or 1200 baud modem (even parity, 7 data bits, 1 stop bit). In CT, call 203-852-1239.

Please send more information about VideoLog.

DE EDN 820

Name__________
Title__________ Mail Stop__________
Company__________
Address__________
City__________
State__________ Zip__________
Telephone (______) __________
Area Code



CIRCLE NO 137

# Marconi?
# 'Make radar don't they?'
# And Industry Standard ASIC

We are Marconi Electronic Devices and we make leading edge ASICs at the heart of tomorrow's systems, created by us, in Europe and sold worldwide.

Some of our products are customer-specific semicustom, some market-specific standard products.

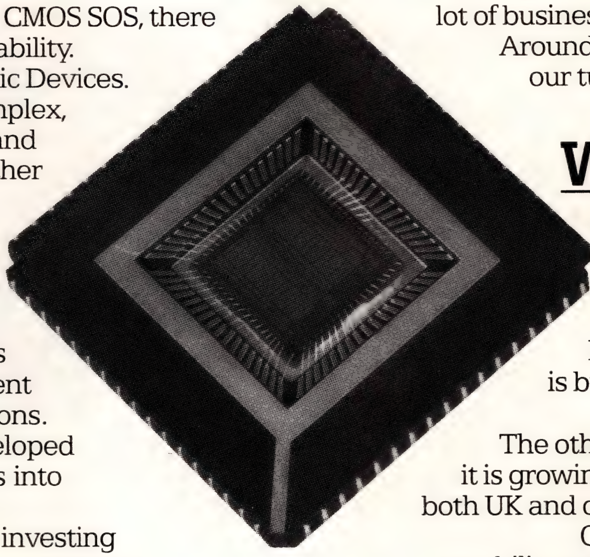
All are specialist and in many areas, like space, telecommunications, defence, we are the preferred choice.

For some ICs, like CMOS SOS, there is only one name for our capability.

Marconi Electronic Devices.

We make the complex, understandable, affordable and attainable in a way that no other organisation can match.

Our resources, human and physical, are the best in the world, and we frequently create ASICs which extend systems capability for the advancement of industry, telecommunications. space, defence, And we developed the initiative to put CAD tools into customers' hands.



This year we are investing more than £25m in our silicon business.

We have just completed a new Class 10 wafer fabrication facility to exploit technologies of 1.5 micron and below. And our new plastic packaging unit can manufacture conventional and surface mount at costs which undercut traditional offshore suppliers

Marconi Electronic Devices does a lot of business with GEC companies.

Around 60% of our turnover.

## 'An in-ho
## Wrong. Our IC

But that is not surprising GEC companies handle a l of leading edge contracts and for much of their leading edge ASIC needs the is but one supplier.

Marconi Electronic Devic

The other 40% of our business, and it is growing, comes from many compan both UK and overseas.

Our doors, our know-how, our capability, are open to everybody who has need, which we can fulfil better than most

Marconi Electronic Devices do not

# MEDL?
# 'Make ordinary, run-of-the-mill products.'
# CMOS SOS ordinary? You must be joking.

## "Fast Little Movers" from MEDL's DSP range...

**Fast, powerful, multifunctional, programmable processors and building blocks for Digital Signal Processing** and computing have been developed by MEDL primarily for the design of flexible systems utilizing minimum board area.

Following on from MEDL's world-leading **Correlator, the MA7170,** initial offerings extend the family of devices, taking and enhancing current industry standards to meet the requirements of faster throughput, low power and European origin.

**MA7010 – 16 × 16 Multiplier Accumulator**

- Pin for pin compatible with the TDC 1010, IDT 7210 and other industry available MACS.
- Greatly improved Multiply-Accumulate Rate through optional pipeline. < 30 nS versus fastest equivalent at 45 nS (published data).
- Manufactured in MEDL's proven SOI technology for speed and applicability to all industry sectors including Industrial and Space/Defence.

**MA7001 – 512 × 9 FIFO**

- Pin for pin compatible with MK4501 and IDT 7201.
- Manufactured in SOI – Greatly improving power consumption – 250 mW compared to 600 mW (nearest speed equivalent part).
- Applicable to all industry sectors including Industrial and Space/Defence.

Next in line for release are a **Real-Time Image Processing Chip Set** consisting of two processing elements:

The **MA 7180 2D Convolver** for linear filtering.
The **MA 7190 Rank Order Filter** for non-linear filtering.

Supported by:

The **MA 7186 Video Line Buffer.**
The **MA 7188 Cascade ALU** for cascading Convolvers or for stand alone applications.

This chip set offers the highest performance available in the market.

ıke any old ASICs. Only the best.

Our CMOS and SOS technologies include ›rld leading dialler circuits, high performance AMS in SOS, microprocessors, complex DSP cuits, gate arrays to 10,000 gates, d Cell-based CELLMOS, CELLSOS, ACROMOS and MACROSOS stems with both precision alogue and digital functions.

In short, one of the widest and most successful portfolios of advanced custom and specialist semi-conductor devices and

## DL?
## supplier to GEC.'
## ıbility is for everybody.

b-systems that has ever been assembled.

We entered the SOI sector before most ›ople gave it a thought. Products like our 3 micron ELLSOS wrote the spec for rad hard systems, and e the industry standard. Others, like r MA9000 family of DLM SOS Gate rrays, were a commercial world first.

Our standard VLSI products fer a unique level of technical excellence.

The achievements, the success of arconi Electronic Devices, are no accident. e select our application sectors very carefully.

And then succeed.

Since Marconi Electronic Devices was rmed in 1980 we have increased turnover by ore than 50% every 12 months.

And we spread our sales net very wide.

Around 45% of our business is abroad.

This year exports will exceed home ›mand. And there will be no resting on our laurels.

In the States, for instance, we are working flat out to keep up with demand where our newly formed Marconi Electronic Devices Inc. is already

## MEDL?
## 'Slow to grab new business.'
## No way. Look at our IC growth.

creating semicustom designs and supplying VLSI products for high level space and defence projects.

In Europe, and throughout the rest of the world, we are a major supplier of telecomms and industrial ASICs. Find out more.
Telephone Charlie Edgington (Space/Defence) or John Hills (Telecomms/Industrial) on 0522 688121.

You'll find they know what they're talking about, and more importantly they will know what you're talking about.

Our receptionist will answer Marconi Electronic Devices, not MEDL.

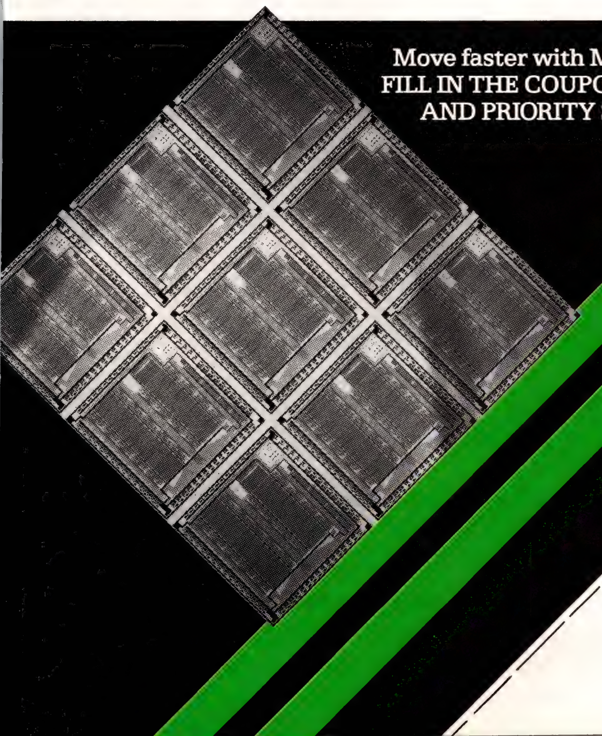
## Marconi Electronic Devices?
## 'No. We deal with MEDL.'
## MEDL is ......

# Marconi
ELECTRONIC DEVICES

IC Division, Doddington Road, Lincoln LN6 3LF
Telephone: 0522 688121

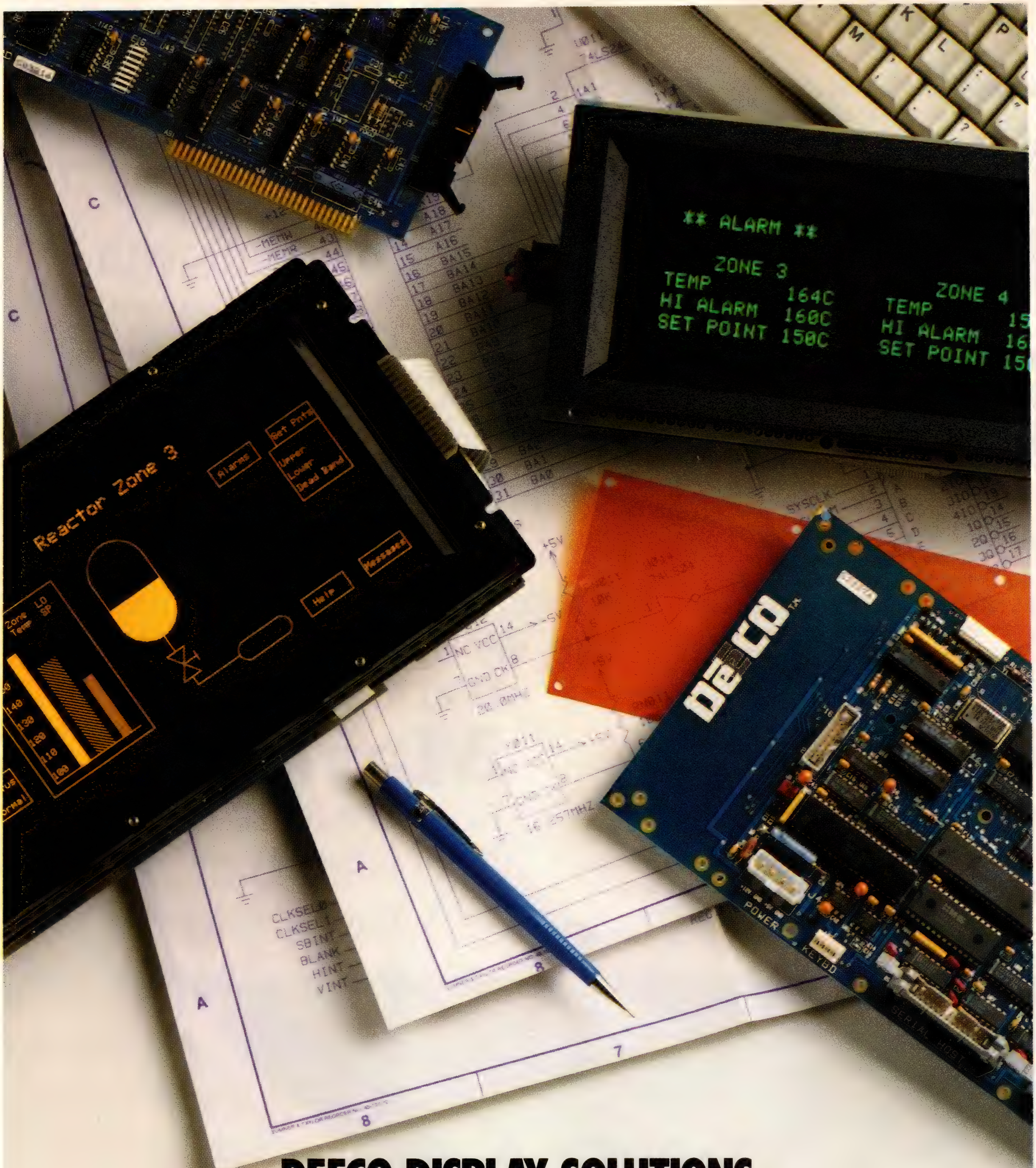
A leaders edge.

CIRCLE NO 134



Move faster with MEDL DSP ...
FILL IN THE COUPON FOR DATA
AND PRIORITY SAMPLES

To: Graham Smith, DSP Marketing, IC Division, Marconi Electronic Devices Ltd., Doddington Road, Lincoln. LN6 3LF Tel: 0522 688121
Please: ☐ Send me MAC data. ☐ Send me FIFO data.
☐ Keep me up-to-date with the release of your new Image Processing Chip Set data.
Make an appointment to come and see me ☐
Name
Telephone No.
Company
Job title
Address
Postcode
EDN 082087



** ALARM **
ZONE 3
TEMP 164C
HI ALARM 160C
SET POINT 150C
ZONE 4
Reactor Zone 3
Alarms
Set Pnts
Upper
Lower
Dead Band
Messages
Help
POWER
KEYBD

# Signal conditioning circuits use µpower design techniques

*Part 1 of this 2-part series covered micropower signal conditioning for sensors and transducers. Part 2 completes the series with coverage of the types of micropower circuits and techniques required for implementing A/D converters, V/F converters, low-power regulator circuits, and a sample/hold circuit. This part also includes a discussion of the parasitic effects of test equipment on the measurement and design of micropower circuits.*

Jim Williams, *Linear Technology Corp*

When designing micropower circuits, some sensors and transducers can present special problems because of the components' inherently low impedance and low output voltage (see EDN, August 6, 1987, pg 123). Although these constraints don't apply to all transducer-based circuits, other factors can affect circuit performance when attempting to operate them at micropower levels. In data converters, for example, circuit speed, accuracy, and resolution all tend to suffer at low operating current. In addition, a circuit's capacitance can slow its operation, and tradeoffs are sometimes necessary between signal levels and power dissipation.

Although integrating 12-bit A/D converters that have low power consumption are available, they are quite slow—typically in the 100-msec range. Higher speeds require a successive-approximation register (SAR). To date, no commercially produced 12-bit SAR features micropower capability, which is defined as the capability of operating below 1 mA. The design shown in **Fig 1a** converts in 300 µsec while consuming only 890 µA.

Conceptually, this design is a straightforward SAR converter, except that the circuit uses special measures to operate at low power. The circuit arranges the SAR chip and the DAC chip in the standard fashion, with $IC_1$ closing the loop. Normally, one would not use CMOS DACs for SAR applications because their output capacitance slows down the operation. In this case, however, the CMOS DAC's low power consumption is attractive enough that the consequently slower speed is acceptable. And because the micropower comparator ($IC_1$) works well with the speed of the DAC specified, the speed penalty is minimal.

One limitation of CMOS DACs is that their outputs must terminate into 0V. This constraint mandates a current-summing comparison, wherein the reference's polarity must be the opposite of the input's. Because most micropower systems run from single-sided positive rails, it's unrealistic to expect the end user to supply the A/D converter with a negative input. To be readily usable, therefore, the converter should accept positive inputs and derive a negative reference internally. $IC_2$ and the LTC1044 address this issue with a plus-to-minus voltage conversion that results in a negative reference. $IC_2$, compensated as an op amp, controls the LTC1044 via the boost transistor. The negative

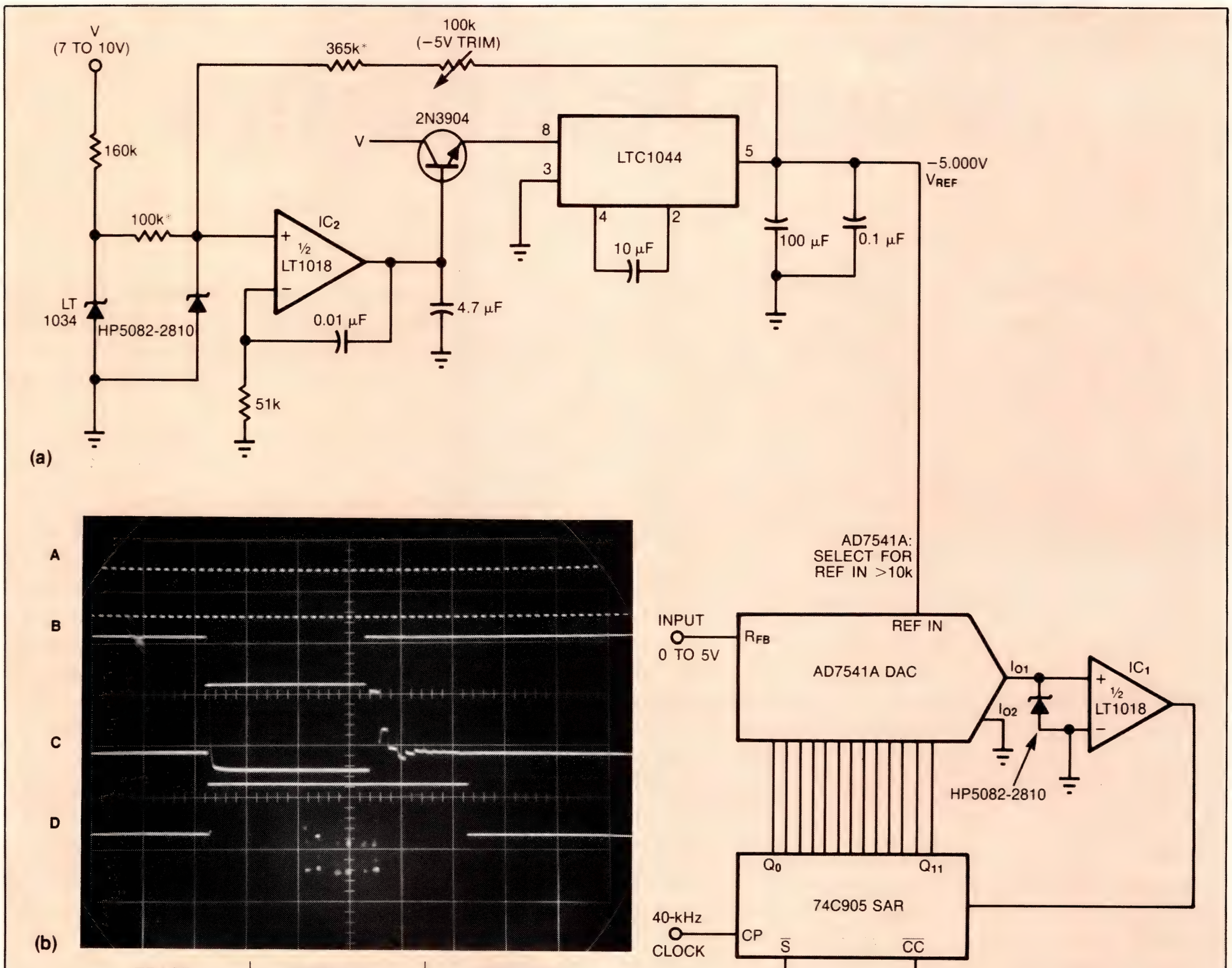
*With micropower circuits you can build A/D converters that offer 10- and 12-bit resolution but consume well under 1 mA of current.*

output of the LTC1044 is fed back to the input of $IC_2$, closing a regulation loop.

Scaled current summing from the output and from the LT1034 forces a −5.000V output. The Schottky diode prevents any negative summing-point overdrive during start-up. The 5V reference maintains a reasonable LSB overdrive for $IC_1$, but it accounts for over half the circuit's current requirement. (The DAC's relatively low input impedance sets this current requirement.) Dropping the reference voltage might save significant power, but it also reduces the LSB size below a millivolt. And an LSB below a millivolt causes both comparator offset and gain to become substantial error sources.

### DAC accepts negative reference

Although the DAC has no negative supply, it can accept the negative reference because its thin-film resistors are extrinsic to its monolithic structure. However, $IC_1$, which is referred to ground, cannot accept



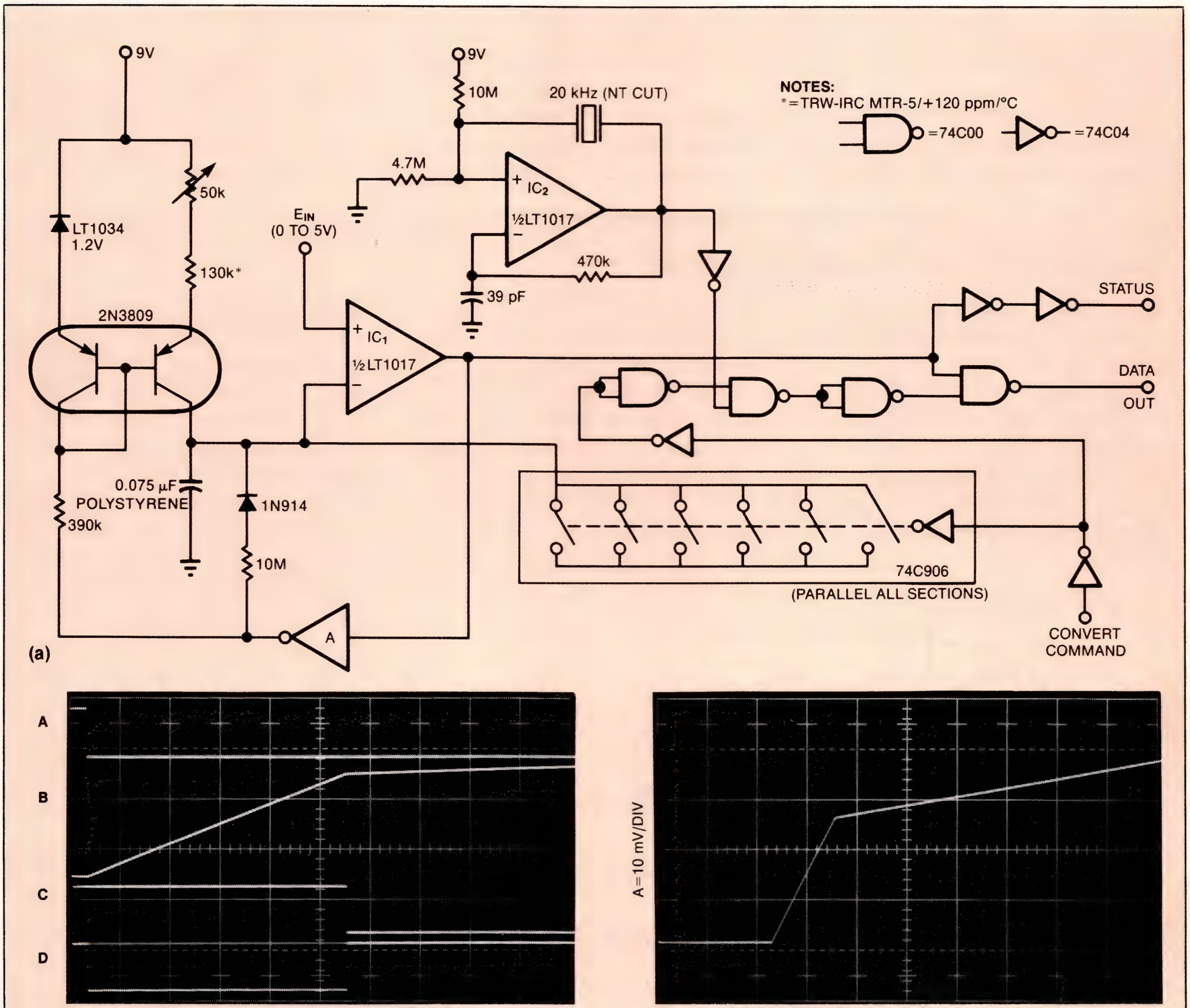

| TRACE | VERTICAL | HORIZONTAL |
|---|---|---|
| A | 10V/DIV | 150 μSEC/DIV |
| B | 10V/DIV | 150 μSEC/DIV |
| C | 100 mV/DIV | 150 μSEC/DIV |
| D | 10V/DIV | 150 μSEC/DIV |

***Fig 1—This 12-bit A/D converter needs only 890 μA of current.*** *It uses a successive approximation approach that provides conversion in 300 μsec.*

any negative voltages and is clamped by the Schottky diode. Overall performance specifications include typical temperature compensation of 30 ppm/°C, a 300-μsec conversion time, an 890-μA current consumption, and an accuracy of ±2 LSBs. To trim, adjust the 100-kΩ resistor for exactly −5V at $V_{REF}$.

The DAC's internal feedback resistor serves as the input. In **Fig 1b,** trace A is the clock, and trace B is the convert command. Trace B's falling edge clears the SAR, and conversion commences on its rise. During conversion, $IC_1$'s input (trace C) sequentially converges towards zero. When conversion is complete, the status line (trace D) drops low.

The 10-bit A/D converter shown in **Fig 2a** has less




| TRACE | VERTICAL | HORIZONTAL |
|---|---|---|
| A | 10V/DIV | 2 mSEC/DIV |
| B | 0.5V/DIV | 2 mSEC/DIV |
| C | 10V/DIV | 2 mSEC/DIV |
| D | 10V/DIV | 2 mSEC/DIV |

***Fig 2—Using CMOS logic elements and a low-current comparator,*** *this 10-bit A/D converter requires only 100 μA of current.*

*An S/H circuit that has a 20-μsec acquisition time and a hold current of 430 μA uses low-current op amps, CMOS logic, and a handful of discrete components.*

resolution than the previous circuit, but it does operate at the much lower current of 100 μA. The design consists of a current source, an integrating capacitor, a comparator, and some logic elements. With a pulse applied to the convert-command input (trace A, **Fig 2b**), the paralleled 74C906 sections reset the 0.075-μF capacitor to zero (trace B). Simultaneously, 74C04 inverter A goes low, biasing the 2N3809 current source on. During this interval, the current source stabilizes and delivers its output to ground via the paralleled 74C906 sections.

On the falling edge of the convert-command pulse, the 0.075-μF capacitor begins to charge linearly. When the ramp voltage equals the input, $IC_1$ switches and inverter A goes high, shutting off the current source. A small current is bled through the 10-MΩ resistor and the 1N914 diode to keep the ramp charging at a lower rate. That current ensures overdrive for $IC_1$ but minimizes the current source's on time and so saves power. The 0 to 5V input voltage ($E_{IN}$) to $IC_1$ directly determines the output pulse width (trace C). This pulse gates $IC_2$'s clock output via the 74C00 configuration. The 74C00s also gate the portion of $IC_1$'s output that results from the control-command pulse. Thus, the clock pulse bursts that appear at the output (trace D) are proportional to $E_{IN}$. For the arrangement shown, 1024 pulses appear for a 5V full-scale input.

The specified current-source scaling resistor and the

## Parasitic effects of test equipment

The energy absorbed by test-equipment connections to micropower circuits can be significant. Under normal circumstances, test equipment and probes have negligible power drain, but microampere-level operating currents require care. You should regard test instrumentation as an integral part of the circuit and keep ac and dc loading and parasitic effects in mind in order to avoid unpleasant surprises. Errors in instrument connection can make the circuit under test look unfairly bad or good.

The dc resistance of oscilloscope probes varies from hundreds of ohms (1× probes) to 10 megohms (10× probes), with some 10× probes as low as 1 MΩ. Even some FET probes do not have as high an input resistance as one might expect—some types are as low as 100 kΩ, although most are about 10 MΩ. The dc loading of a 10× 1-MΩ probe on the circuit in **Fig 2** (pg 221), for example, could introduce as much as 9 μA of loss—almost 10% of the total current drain. The ac loading of a 10-pF probe, using **Fig 2's** 20-kHz clock as a test example, increases circuit current by 5 μA momentarily, a significant loss in a low-power circuit.

Most 1× probes present about 50-pF loading, with a 1-MΩ dc resistance when connected to the oscilloscope. This kind of probe loading can cause large errors in some micropower circuits; it can virtually disable others. Such a probe, when connected to the collector of $Q_8$ in **Fig 5** (pg 227), results in a 25% momentary increase in circuit current at an output of 1 MHz.

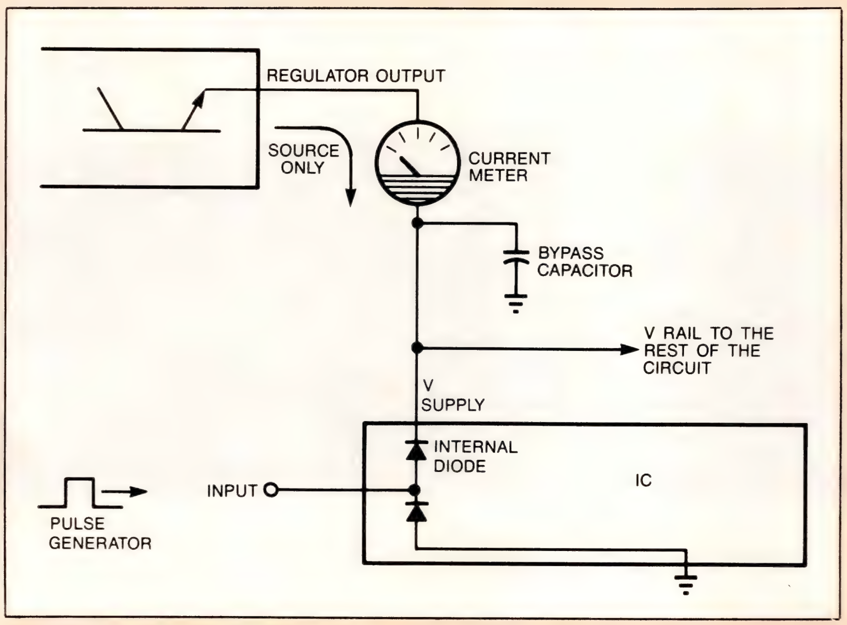



***Fig A—Test equipment can make a circuit look better than it is.*** *If you misadjust the pulse generator, for example, the circuit functions when the current meter reads zero.*

specified ramp capacitor provide good temperature compensation because of their opposing thermal coefficients. The circuit typically maintains an accuracy of ±1 LSB over the temperature range of 0 to 70°C; the asynchronous relationship between the clock and the conversion sequence causes an additional ±1 LSB. The conversion rate varies with the input voltage. At 1⁄10 scale, 150 Hz is possible; at full scale, the rate decreases to 20 Hz.

**Lowest power sacrifices accuracy**

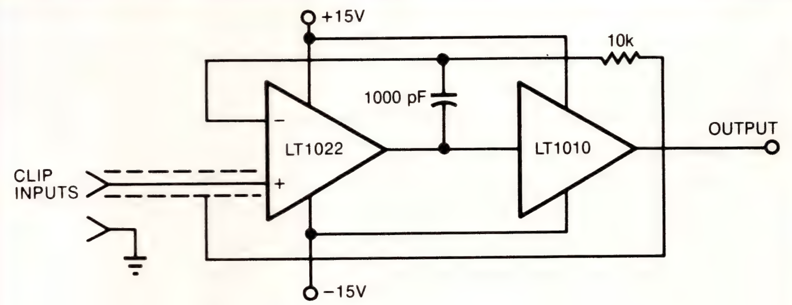
Power consumption of this A/D converter is extremely low because of the CMOS logic elements and the LT1017 comparator. Quiescent current ($E_{IN}$ equals 0V) is 100 μA at a supply voltage of 9V, decreasing to 80 μA at 7V. Because the time that the current source is on varies with the input, power consumption also varies with $E_{IN}$. When $E_{IN}$ equals 5V, current drain rises to 125 μA with a 9V supply and 105 μA at 7V. You can save more power if you shut off the current source during the capacitor reset, but you lose accuracy because of the current source's settling-time requirements. The accumulated charge on the 0.075-μF capacitor is lost at each reset. A smaller capacitor might help, but $IC_1$'s bias currents introduce significant error in this case.

Turning off the current source after $IC_1$ switches also saves significant power. **Fig 2c**, taken at a 25-mV input,

Probe ac and dc loading are not the only effects. The input switching networks of some DVMs (digital voltmeters) sink or source a parasitic charge. Such a parasitic charge, when introduced into high-impedance nodes, can cause substantial errors. It's also worth remembering that DVM dc loading may change with the range it is set to: Lower ranges may have a very high input impedance, but higher ranges typically have only 10 MΩ.

**Fig A** shows a way that test equipment can make the circuit look too good. If you adjust the pulse generator more than a typical diode voltage drop above the regulator's output, the bypass capacitor will detect the peak charge delivered through the IC's internal diode. The regulator can't sink current, and, with its output forced high, it won't source anything either. Under these conditions, the circuit functions when the current meter reads zero—a very low-power circuit indeed.

A very simple and useful circuit **(Fig B)** greatly aids probe-loading problems in micropower circuits. The LT1022 high-speed FET op amp drives an LT1010 buffer. The output of the LT1010 drives the DVM cable and probe and also biases the circuit's input shield. This connection bootstraps the input capacitance and reduces its effect. Both the dc and ac errors of this circuit are low enough for nearly all work, with enough bandwidth for most low-power circuits. If you build this circuit in a small enclosure with its own power supply, you can use it ahead of an oscilloscope or DVM with good results. The pertinent specifications appear in **Fig B.**




**CIRCUIT CHARACTERISTICS**

| | |
|---|---|
| INPUT CAPACITANCE | ≈8 pF |
| $I_B$ | 50 pA |
| GAIN BANDWIDTH | 8.5 MHz |
| SLEW RATE | 23V/μSEC |
| $E_{OS}$ | 250 μV |
| $E_{OS}$ ΔTEMPERATURE COEFFICIENT | 5 μV/°C |

***Fig B—To aid in probe-loading problems,** this circuit provides ac and dc errors that are low enough for nearly all work.*

*Using micropower circuits and appropriate design techniques, 10-kHz and 1-MHz V/F converters need only 145 μA and 635 μA of current, respectively.*

shows the ramp zero reset and clean switching. When the current source switches off, the ramp slope decreases but still continues to move upward, ensuring overdrive. The 10-MΩ resistor and the 1N914 diode provide the charge, and less than a microampere is lost.

**Fig 3a** shows a companion sample/hold circuit for the SAR A/D converter. The acquisition time is 20 μsec, with low-power operation (see table in **Fig 3a**). This circuit takes full advantage of the programming pin on the LT1006 op amp to maximize both speed and power specifications. When the sample command (trace A, **Fig 3b**) is given, the CO4066 switch closes. $S_1$ and $S_2$ allow the output of $IC_1$ (trace B) to charge the capacitor (trace C is the capacitor current). $S_3$ and $S_4$ also close, raising the op amp's internal bias network.

At that point, both amplifiers then go into hyperdrive, boosting the slew rate in order to speed the acquisition time. $IC_2$ (trace D) settles cleanly to 1 mV in 20 μsec. When the sample command goes low, all switches go off, $IC_2$ follows the voltage stored on the capacitor, and the supply current drops by a factor of five (see the table in **Fig 3a**). In normal operation, the sampling time is short compared to the holding time, and current consumption is low. The 360-kΩ resistors set the circuit's hold-mode quiescent current at 430 μA.

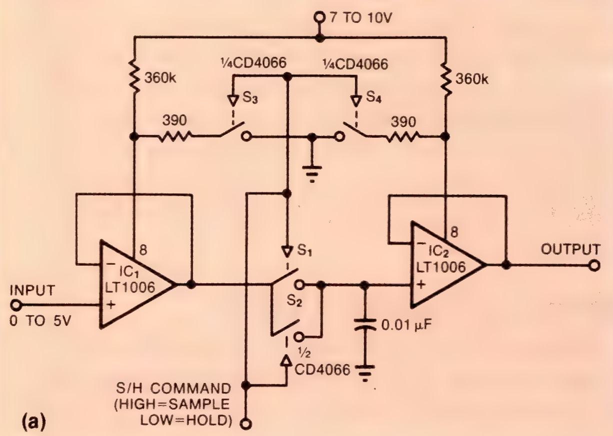
### V/F converters also work at low current

Another data converter, this one a voltage/frequency (V/F) converter, is shown in **Fig 4a**. A 0 to 5V input produces a 0- to 10-kHz output with a linearity of 0.02% and a gain drift of 40 ppm/°C. Maximum current consumption is only 145 μA, far below that required by most other circuits.

To understand how the **Fig 4** circuit operates, assume that the positive input to $IC_1$ is slightly below its negative input and that the output of $IC_2$ is low. The input voltage causes a positive ramp at the input of $IC_1$ (trace A, **Fig 4b**). $IC_1$'s low output biases the CMOS-inverter outputs high. This bias allows current to flow from $Q_1$'s emitter through the inverter supply pin to the 0.001-μF capacitor. The 10-μF capacitor provides a high-frequency bypass, maintaining a low impedance at $Q_1$'s emitter. Connected like a diode, $Q_6$ provides a path to ground.

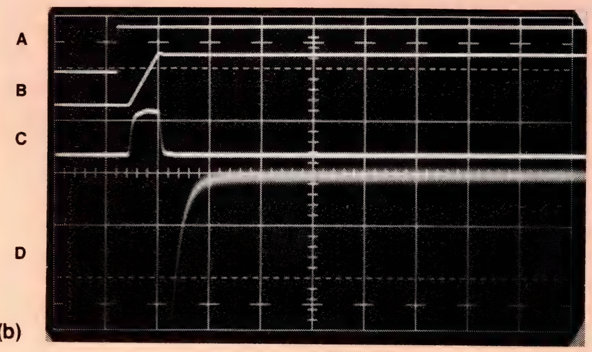
The 0.001-μF capacitor charges to a voltage that is a function of $Q_1$'s emitter potential and the drop across $Q_6$. When the ramp at the positive input of $IC_1$ goes high enough, $IC_1$'s output goes high (trace B) and the inverters switch low (trace C). The Schottky clamp prevents a CMOS-inverter input overdrive. This preventative action also pulls current from the capacitor at the positive input of $IC_1$ via $Q_5$ and the 0.001-μF capacitor (trace D). This removal of current resets $IC_1$'s positive input ramp to a potential slightly below ground and thus forces the output of $IC_1$ to go low.

The 50-pF capacitor connected to the circuit output furnishes positive ac feedback, ensuring that the output



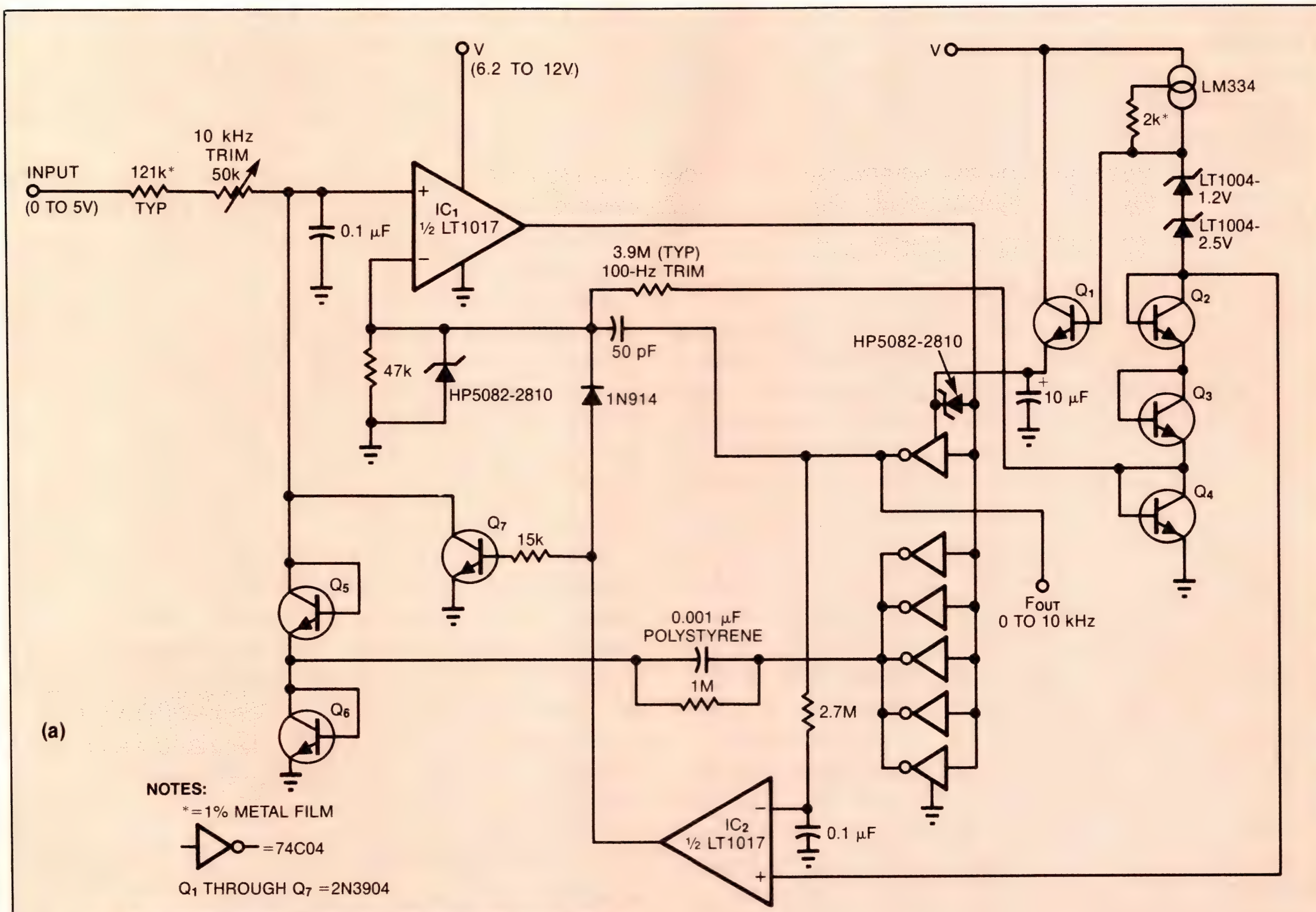

**CIRCUIT CHARACTERISTICS**

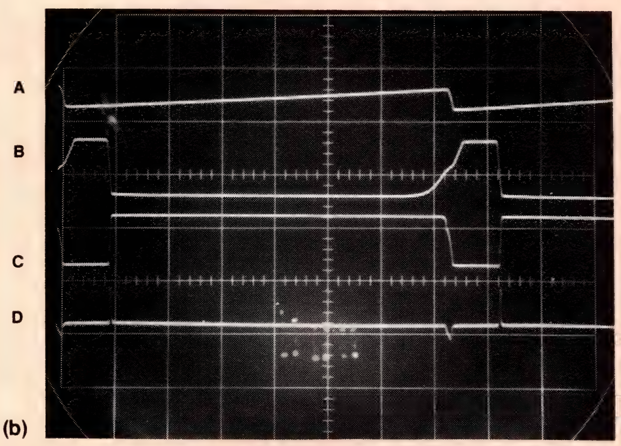
| | |
|---|---|
| ACQUISITION TIME | 20 μSEC |
| HOLD SETTLING TIME | 10 μSEC |
| S/H OFFSET | 1 mV |
| HOLD SUPPLY CURRENT | 430 μA |
| SAMPLE SUPPLY CURRENT | 2.2 mA |
| 1-kHz-SAMPLE-RATE CURRENT | 875 μA |
| DROOP RATE | 1 mV/mSEC |




| TRACE | VERTICAL | HORIZONTAL |
|---|---|---|
| A | 10V/DIV | 10 μSEC/DIV |
| B | 5V/DIV | 10 μSEC/DIV |
| C | 10 mA/DIV | 10 μSEC/DIV |
| D | 5 mV/DIV | 10 μSEC/DIV |

***Fig 3—A companion for the A/D converters,*** *this sample/hold circuit has a 20-μsec acquisition time and a hold-current of 430 μA.*




HORIZONTAL = 20 µSEC/DIV

| TRACE | VERTICAL | HORIZONTAL |
|---|---|---|
| A | 50 mV/DIV | 20 µSEC/DIV |
| B | 5V/DIV | 20 µSEC/DIV |
| C | 5V/DIV | 20 µSEC/DIV |
| D | 10 mA/DIV | 20 µSEC/DIV |

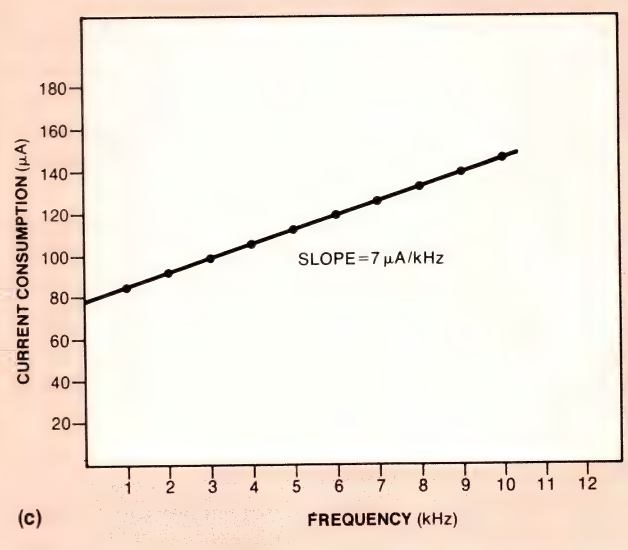



***Fig 4—Linearity for this V/F converter is 0.02%; a 0 to 5V input produces a 0- to 10-kHz output. Maximum current consumption is 145 µA.***

*Switching regulators are useful in limiting quiescent current while still providing higher output currents.*

of $IC_1$ remains positive long enough to completely discharge the 0.001-µF capacitor. The Schottky diode prevents the input of $IC_1$ from being driven outside its negative common-mode limit. When feedback from the 50-pF capacitor decays, $IC_1$ again switches low, and the entire cycle repeats itself. The oscillation frequency depends directly on the input current, which is in turn derived from the voltage.

**Control emitter voltage carefully**

If you want to obtain low drift, you must carefully control $Q_1$'s emitter voltage. $Q_3$ and $Q_4$ provide temperature compensation for $Q_5$ and $Q_6$, and $Q_2$ does the same for $Q_1$'s $V_{BE}$. The two LT1004s act as the actual voltage reference, and the LM334 current source sends 35 µA of bias to the stack. The current drive offers excellent supply immunity (better than 40 ppm/V) and also aids the circuit's temperature coefficient because it uses the LM334's 0.3%/°C temperature coefficient to provide a slight temperature modulation on the voltage drop in the $Q_2$, $Q_3$, $Q_4$ string. The magnitude and sign of this correction directly oppose that of the −120 ppm/°C coefficient of the 0.001-µF polystyrene capacitor and thereby contribute to the circuit's overall stability.

The emitter follower, $Q_1$, delivers a charge to the 0.001-µF capacitor efficiently, as both the base and collector currents end up in the capacitor. The paralleled CMOS inverters provide low-loss spdt reference switching with minimum drive losses. The 0.001-µF capacitor, which is as small as accuracy permits, draws only small transient currents during its charge and discharge cycles, and a combination of the 50-pF capacitor and the 47-kΩ resistor produces positive feedback that draws insignificant switching currents.

**Fig 4c**, a plot of supply current vs operating frequency, reflects the low-power design. At zero frequency, the LT1017's quiescent current and the 35-µA reference-stack bias accounts for all of the current drain. As frequency increases, the charge-discharge cycle of the 0.001-µF capacitor introduces the 7-µA/kHz increase shown. A capacitor of a smaller value would cut power, but the effects of stray capacitance, charge imbalance in the 74C04, and LT1017 bias currents would introduce inaccuracies.

**Start-up can cause feedback latching**

Circuit start-up or overdrive can cause the circuit's ac-coupled feedback to latch. If this occurs, $IC_1$'s output goes high. $IC_2$, detecting this change via the inverters and via the lag caused by the 2.7-MΩ resistor and the 0.1-µF capacitor, also goes high. This sequence lifts $IC_1$'s negative input and grounds the positive input with $Q_7$ and so initiates normal circuit action. Because the charge pump is directly coupled to the output of $IC_1$, the response is fast.

To calibrate this circuit, apply 50 mV and select the resistor value at the input of $IC_1$ for a 100-Hz output. Then apply 5V and trim the 50-kΩ variable resistor for a 10-kHz output.

**Fig 5** shows another V/F converter, but this one runs at 1 MHz full scale. Quiescent current is 245 µA, increasing linearly to 635 µA at 1-MHz output. Obtaining this higher operating frequency requires tradeoffs in linearity, power consumption, and step-response performance. Linearity is 0.12% over the 100-Hz to 1-MHz range; drift is about 50 ppm/°C; and step response is less than 350 msec to full scale.

This circuit has some similarities to **Fig 4**, although the operation is somewhat different. An input voltage causes $IC_1$ to swing toward ground, biasing $Q_8$. $Q_8$'s collector ramp (trace A, **Fig 5b**) charges the 3-pF capacitor; it also charges any stray capacitance associated with $Q_7$ and the 74C14 Schmitt input that is connected to the node. When the ramp reaches the Schmitt's threshold, its output (trace B) goes low, turning on $Q_7$, which is connected like a diode. $Q_7$ discharges the node capacitances and thus forces the ramp to reset. The 74C14 returns to the high state, and oscillation commences.

A second 74C14 section (trace C) inverts this oscillation signal, drives the 74C90 dividers, and serves as the circuit's output. The dividers' ÷100 output (trace D) controls a reference charge-pump arrangement essentially identical to the one in **Fig 4**. The 1000-pF capacitor is alternately charged and discharged by the paralleled 74C14 sections and steering diodes $Q_5$ and $Q_6$, respectively. The charge increments pulled through $Q_5$ continually force $IC_1$'s 2-µF capacitor to zero (trace E), balancing the input-derived current. This action closes a loop around $IC_1$ and thus controls the oscillator, which consists of $Q_7$, $Q_8$, and the 74C14, so that it runs at the frequency needed to keep its own negative input at zero. This closed loop eliminates oscillator drift and nonlinearity as error sources. The 0.33-µF capacitor at $IC_1$ stabilizes the loop and accounts for the circuit's 350-msec settling time.

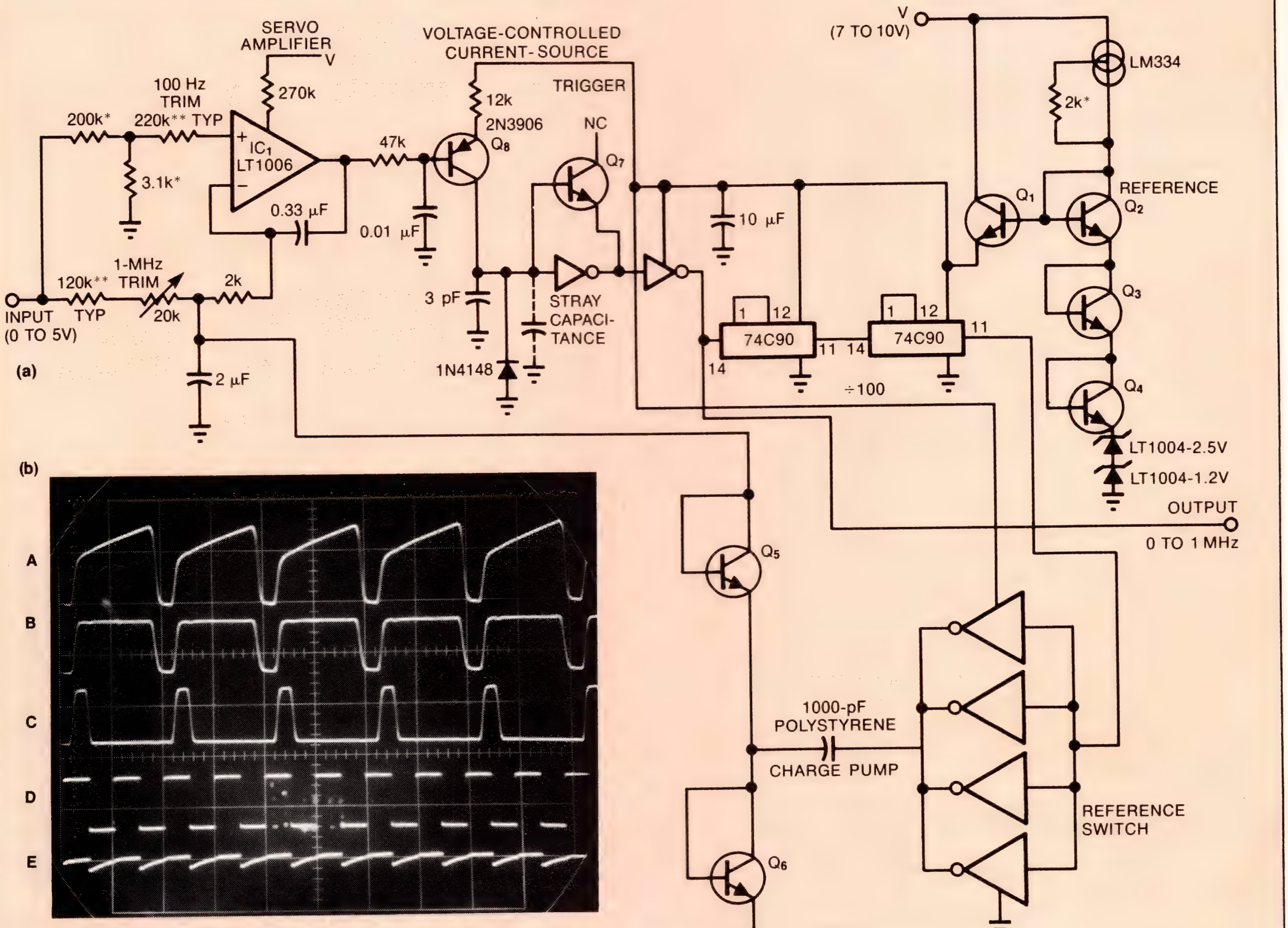
The resistive divider at the input to $IC_1$ improves linearity by summing in a small input-related voltage. By deliberately introducing leakage to ground, the diode at the collector of $Q_8$ dominates all node leakages.

This leakage control ensures low-frequency operation by forcing $Q_8$ to source current for oscillation purposes.

Although low, the current drain of the **Fig 5** circuit is higher than the one shown in **Fig 4**, primarily because of the former's high-frequency oscillator and its divider operation. The capacitance and the signal swing at the collector of $Q_8$ heavily influence the oscillator's current. The 74C14 threshold voltage determines the signal swing, and the capacitance value is the lowest possible value commensurate with the desired low-frequency operation.

To trim this circuit, apply 500 μV to the input and select the 220-kΩ (typ) resistor value at the positive input of $IC_1$ for an output frequency of 100 Hz. Then, with a 5V input, adjust the 20-kΩ variable resistor for 1-MHz output. Repeat this procedure until both points are fixed.

Any discussion of micropower circuitry is incomplete without mentioning switching regulators. Often you must efficiently convert battery voltages to other voltages to meet circuit requirements. **Fig 6** shows a buck switching regulator with a quiescent current of 70 μA



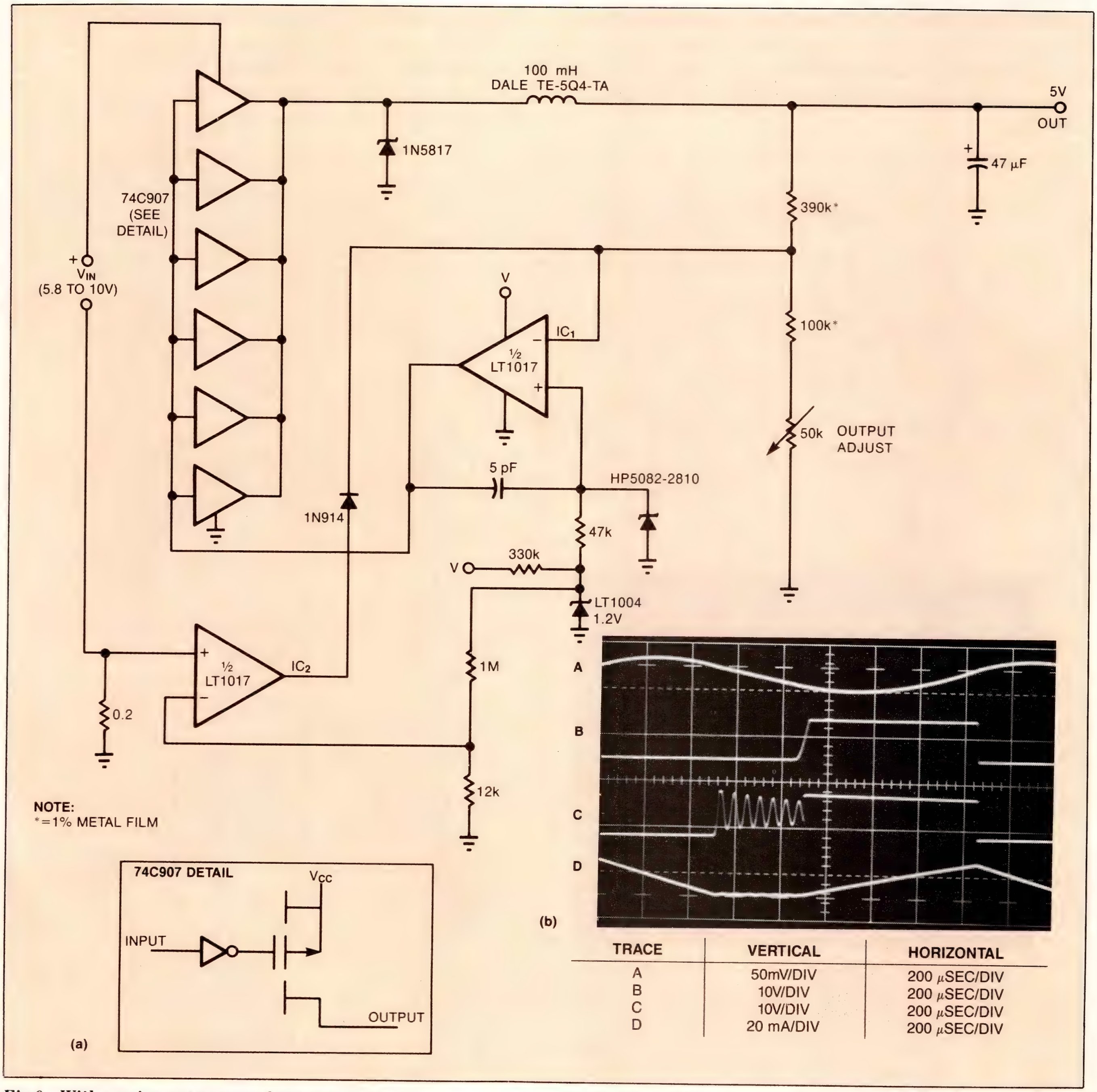

| TRACE | VERTICAL | HORIZONTAL |
|---|---|---|
| A | 2V/DIV | 500 nSEC/DIV |
| B | 5V/DIV | 500 nSEC/DIV |
| C | 5V/DIV | 500 nSEC/DIV |
| D | 5V/DIV | 100 μSEC/DIV |
| E | 1 mV/DIV | 100 μSEC/DIV |

***Fig 5—This V/F converter needs from 245 to 635 μA to operate,*** *but it will run at 1 MHz full scale. Linearity is 0.12% over 100 Hz to 1 MHz.*

*You should regard test instrumentation as an integral part of the circuit when evaluating any circuit design.*

and an output-current capability of 20 mA. When the output voltage drops (trace A, **Fig 6b**), the negative input of $IC_1$ also falls, causing its output (trace B) to rise. This turns on the paralleled 74C907 open-source buffers, and their outputs (trace C) consequently go high. Current increases through the inductor and maintains the regulator output. When the output voltage rises a little, $IC_1$'s output goes low again, and the cycle repeats itself.

In spite of line and load changes, this action main-




| TRACE | VERTICAL | HORIZONTAL |
|---|---|---|
| A | 50mV/DIV | 200 µSEC/DIV |
| B | 10V/DIV | 200 µSEC/DIV |
| C | 10V/DIV | 200 µSEC/DIV |
| D | 20 mA/DIV | 200 µSEC/DIV |

***Fig 6—With a quiescent current drain*** *of only 70 µA and an output capability of 20 mA, this buck switching regulator can efficiently convert battery voltages to lower circuit-voltage requirements.*


☐ 6½ digits, ±3,000,000 counts ☐ 100 nV, 1 nA, 100 μΩ sensitivity ☐ 30 ppm DCV accuracy
☐ Speed: up to 1000 readings/second ☐ Offset compensated or 4-wire ohms
☐ IEEE-488 and exclusive TRANSLATOR software ☐ $1395, complete

KEITHLEY

Call or write Keithley for more information.

Product Information Center, Instruments Division, Keithley Instruments, Inc., 28775 Aurora Road, Cleveland, Ohio 44139, (216) 248-0400.

CIRCLE NO 132

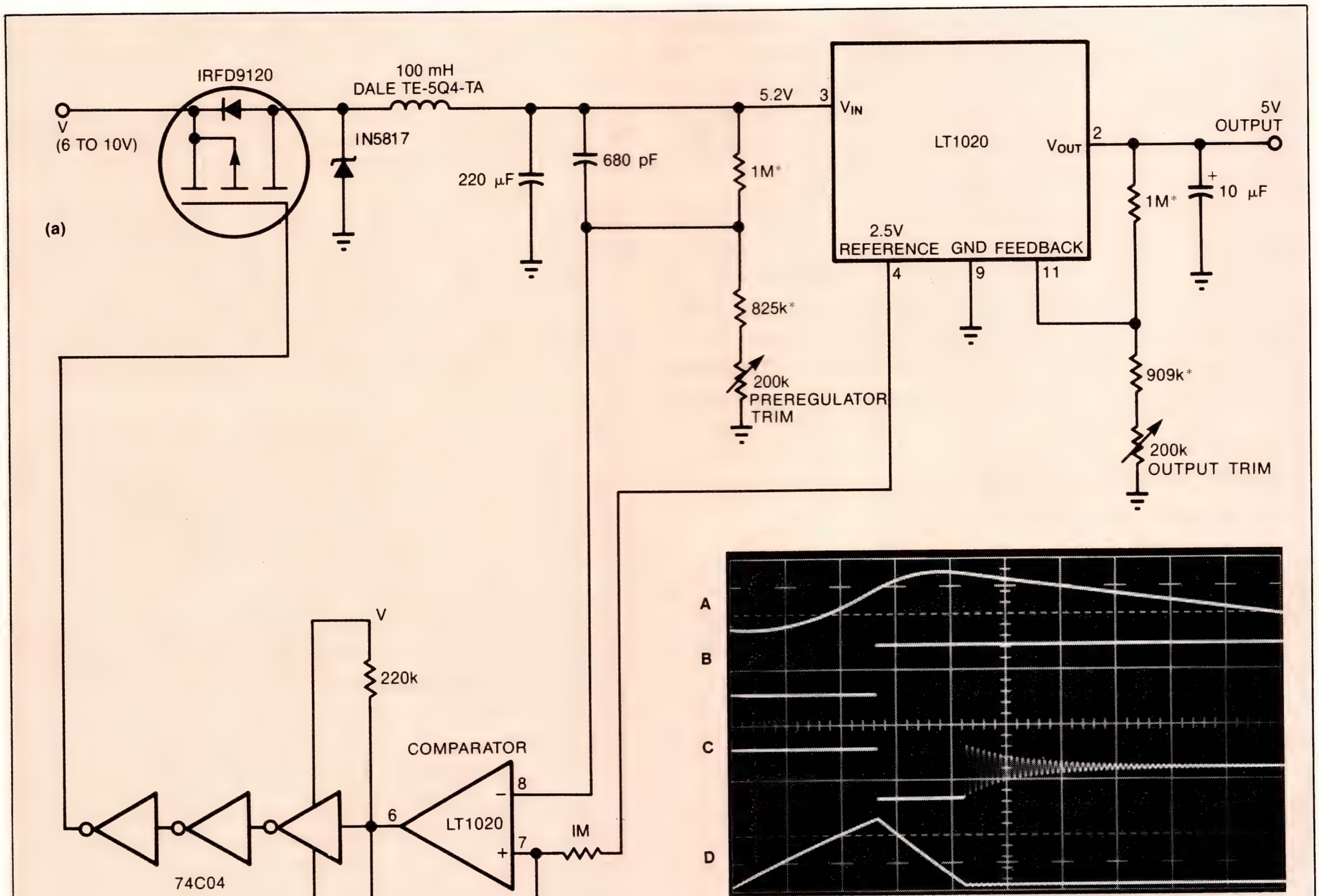
*A linear postregulator can provide lower noise than a straight switching approach.*

tains a constant regulator output. The LT1004 serves as a reference, and the 5-pF capacitor ensures clean switching at $IC_1$. The 2810 Schottky diode prevents negative overdrive caused by the 5-pF capacitor's differentiated response, and the 1N5817 catching diode prevents excessive inductor-caused negative voltages.

The circuit's low quiescent current results from the LT1017's low operating current and the 74C907's low input-drive requirements. The circuit's resistor values are kept high to save current. $IC_2$ shuts down the regulator when output current exceeds 50 mA by comparing the voltage across the 0.2Ω shunt to the voltage across a resistively divided portion of the LT1004 reference. Excessive current drain trips $IC_2$ high and so forces $IC_1$'s negative input high. This action removes drive from the 74C907 buffers and shuts down the regulator. Using a CMOS buffer as a pass switch for a switching regulator is unusual, but the results are quite good. Efficiencies as high as 90% are possible with an output current to 20 mA.

## Linear postregulator reduces noise

Another buck switching regulator **(Fig 7a)** features a low-loss linear postregulator, a quiescent current of 40 μA, and an output current to 50 mA. The LT1020 linear regulator provides lower noise than would a straight




| TRACE | VERTICAL | HORIZONTAL |
|---|---|---|
| A | 50 mV/DIV | 500 mSEC/DIV |
| B | 10V/DIV | 500 mSEC/DIV |
| C | 10V/DIV | 500 mSEC/DIV |
| D | 100 mA/DIV | 500 mSEC/DIV |

***Fig 7—This buck switching regulator circuit includes a linear postregulator.*** *Providing a smoother output and lower noise than a straight switching regulator, this circuit has a quiescent current of only 40 μA and an output-current capability of 50 mA.*

*In many processor-based systems, it's desirable to monitor or control the power-down sequence.*

switching approach. It also offers internal current limiting and contains an auxiliary comparator that helps form the switching regulator in this circuit.

The switching loop is similar to that of the previous circuit. A drop at the output of the switching regulator (pin 3 of the LT1020 regulator, trace A in **Fig 7b**) causes the LT1020's comparator to go low. The 74C04 inverter chain switches and so biases the gate of the p-channel MOSFET (trace B). The MOSFET turns on (trace C), delivering current to the inductor (trace D). When the voltage at the junction of the inductor and the 220-μF capacitor goes high enough (trace A), the comparator switches high and turns off current flow in the MOSFET. This switching loop regulates the LT1020's input pin at a value set by the resistive divider at the comparator's negative input and the LT1020's 2.5V reference. The 680-pF capacitor stabilizes the loop, and the 1N5817 serves as the catching diode. The 270-pF capacitor aids comparator switching, and the 2810 Schottky diode prevents negative overdrives.

The low dropout LT1020 linear regulator smooths the switched output. The output voltage is set by the resistive divider connected to the feedback pin. A potential problem with this circuit involves start-up. The switching loop supplies the LT1020's input, but it relies on the LT1020's internal comparator to function. As a result, the circuit needs the start-up mechanism

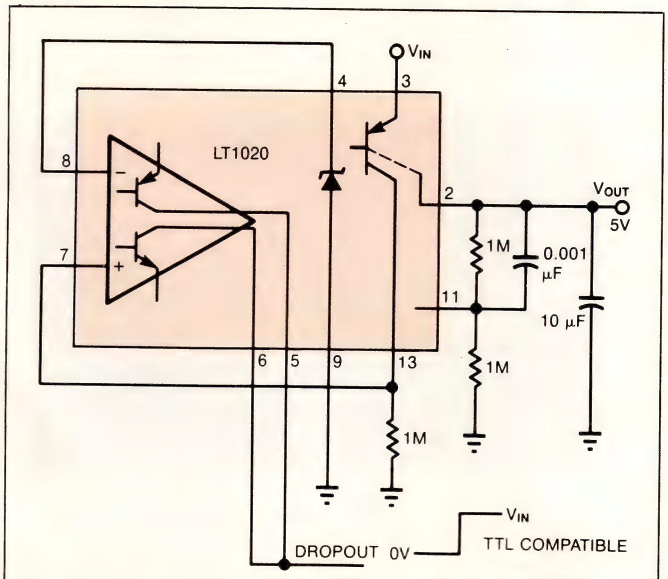



***Fig 8—Using an LT1020 micropower regulator,*** *this circuit is useful in processor-based systems to monitor or control the power-down sequence. It produces a logical-one output when the regulator drops out.*

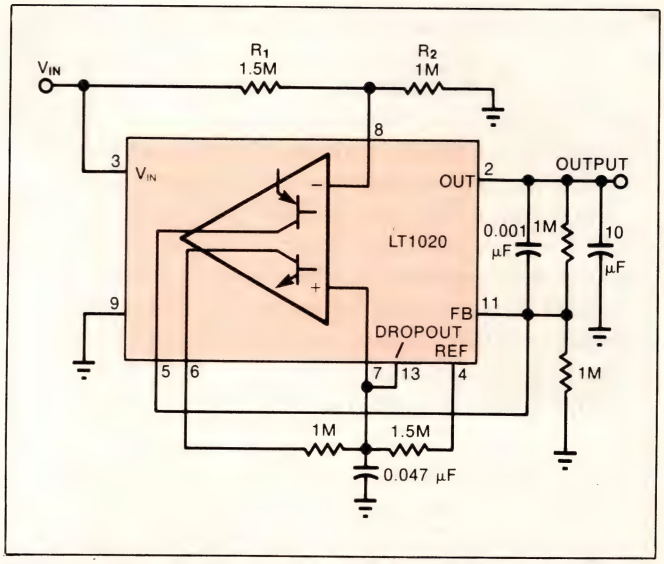
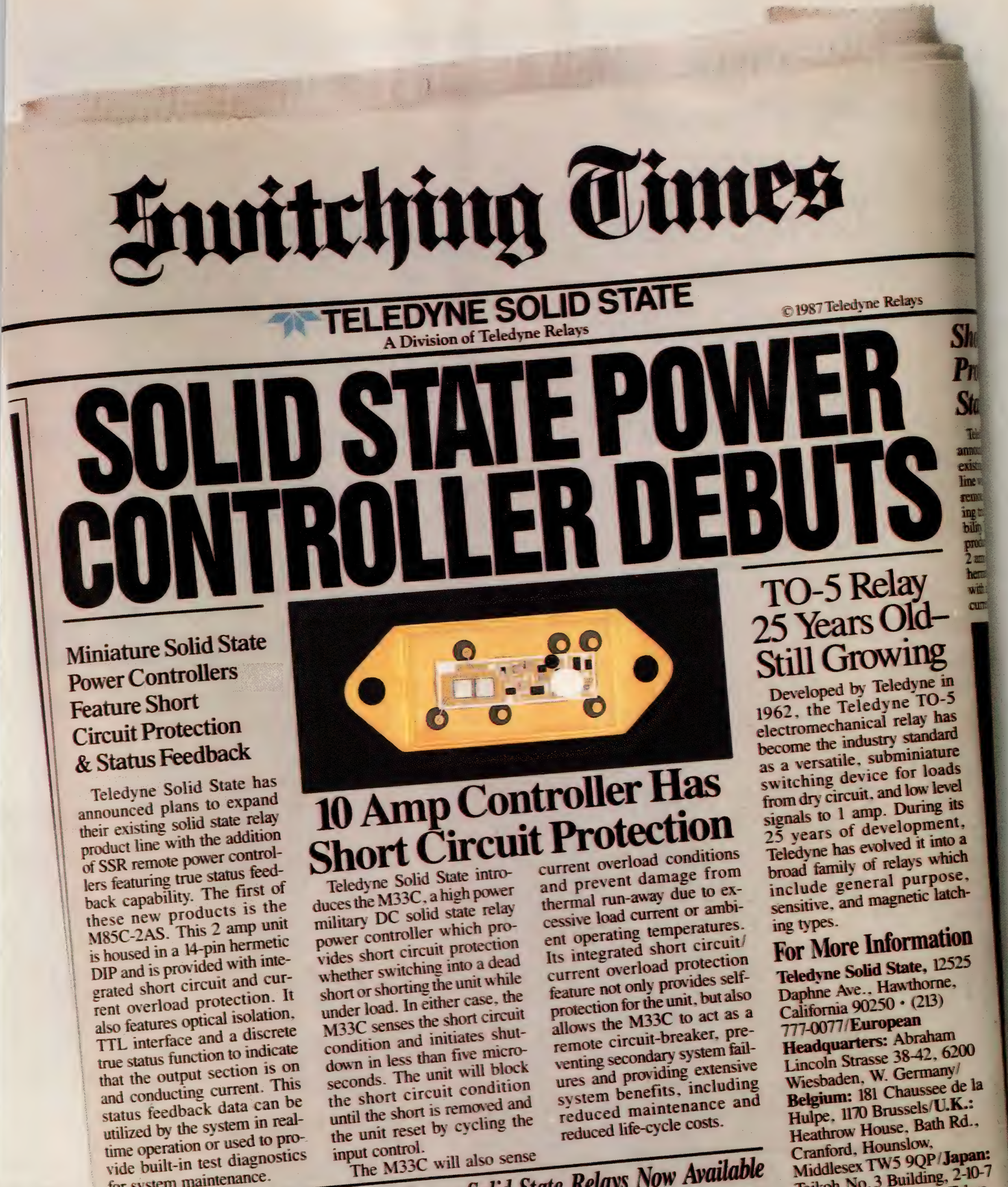



***Fig 9—Similar to Fig 8, this circuit turns the power off when dropout occurs,*** *preventing unregulated supply conditions.*

provided by the 74C04 inverters. When power is applied, the LT1020 receives no input, but the inverters do. The 220-kΩ resistor lifts the first inverter high, which causes the chain to switch and biases the MOSFET in order to start the circuit. The inverter's rail-to-rail swing also provides ideal MOSFET gate drive.

Even though this circuit's 40-μA quiescent current is lower than that of the circuit in **Fig 6**, it can source more current. The extremely low quiescent current is a result of the low LT1020 drain and the MOS elements. An efficiency exceeding 80% is possible, and an output current to 50 mA is available.

Two other micropower regulators using the LT1020 are shown in **Fig 8** and **Fig 9**. In many processor-based systems, it's desirable to monitor or control the power-down sequence. The circuit in **Fig 8** produces a logical-one output when the regulator begins to drop out—at low battery voltage, for example. Here, the 1-MΩ feedback resistors program the regulator for a 5V output. The 0.001-μF capacitor provides frequency compensation. The LT1020's internal comparator senses the difference between the chip's 2.5V reference (pin 4) and a sampled voltage derived from the pass-transistor current (pin 13). Just before dropout occurs, the LT1020's pass transistor goes toward saturation, raising the voltage at pin 13. This rise in voltage trips the comparator, whose output then goes high. You can use this signal to alert a processor whose power is about to go down.



# Switching Times

TELEDYNE SOLID STATE
A Division of Teledyne Relays

© 1987 Teledyne Relays

# SOLID STATE POWER CONTROLLER DEBUTS

## Miniature Solid State Power Controllers Feature Short Circuit Protection & Status Feedback

Teledyne Solid State has announced plans to expand their existing solid state relay product line with the addition of SSR remote power controllers featuring true status feedback capability. The first of these new products is the M85C-2AS. This 2 amp unit is housed in a 14-pin hermetic DIP and is provided with integrated short circuit and current overload protection. It also features optical isolation, TTL interface and a discrete true status function to indicate that the output section is on and conducting current. This status feedback data can be utilized by the system in real-time operation or used to provide built-in test diagnostics for system maintenance.

## 10 Amp Controller Has Short Circuit Protection

Teledyne Solid State introduces the M33C, a high power military DC solid state relay power controller which provides short circuit protection whether switching into a dead short or shorting the unit while under load. In either case, the M33C senses the short circuit condition and initiates shutdown in less than five microseconds. The unit will block the short circuit condition until the short is removed and the unit reset by cycling the input control.

The M33C will also sense current overload conditions and prevent damage from thermal run-away due to excessive load current or ambient operating temperatures. Its integrated short circuit/current overload protection feature not only provides self-protection for the unit, but also allows the M33C to act as a remote circuit-breaker, preventing secondary system failures and providing extensive system benefits, including reduced maintenance and reduced life-cycle costs.

## TO-5 Relay 25 Years Old–Still Growing

Developed by Teledyne in 1962, the Teledyne TO-5 electromechanical relay has become the industry standard as a versatile, subminiature switching device for loads from dry circuit, and low level signals to 1 amp. During its 25 years of development, Teledyne has evolved it into a broad family of relays which include general purpose, sensitive, and magnetic latching types.

### For More Information

**Teledyne Solid State,** 12525 Daphne Ave., Hawthorne, California 90250 • (213) 777-0077/**European Headquarters:** Abraham Lincoln Strasse 38-42, 6200 Wiesbaden, W. Germany/**Belgium:** 181 Chaussee de la Hulpe, 1170 Brussels/**U.K.:** Heathrow House, Bath Rd., Cranford, Hounslow, Middlesex TW5 9QP/**Japan:** Taikoh No. 3 Building, 2-10-7 Shibuya, Shibuya-Ku, Tokyo, 150 Japan/**France:** 85-87 Rue Anatole-France, 92300 Levallois-Perret

## *35 Amp Version of Popular 652 Power Solid State Relays Now Available*

Teledyne Solid State Series 652 military AC solid state relays now offer a 35 amp version, as well as the popular MIL QPL 25 amp model. The new 35 amp unit provides all the features which have made the 652 a best-seller. These include optical isolation, zero voltage turn-on, logic compatible input current levels, and resistance to shock and vibration at military levels.

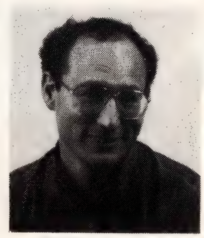
CIRCLE NO 130

Fig 9 is similar, except that this circuit turns the power completely off when dropout occurs, preventing unregulated supply conditions. The comparator feedback arrangement is for a hysteretic response. The output turns off at dropout if

$$\text{TURN ON} = V_{IN} \times \frac{R_2}{R_1 + R_2} = 2.5V.$$

This setup prevents gradual battery-voltage reapplication, which can cause oscillation. **EDN**

## Author's biography



*Jim Williams, staff scientist at Linear Technology Corp (Milpitas, CA), specializes in analog-circuit and instrumentation design. He has served in similar capacities at National Semiconductor Corp, Arthur D Little Inc, and the Instrumentation Development Lab at the Massachusetts Institute of Technology. A former student of psychology at Wayne State University, Jim enjoys tennis, art, and collecting antique scientific instruments.*

Article Interest Quotient (Circle One)
High 494 Medium 495 Low 496

# GET US INVOLVED EARLY ENOUGH AND YOU'LL GET MORE THAN YOU BARGAINED FOR.

Call us anytime and you're in line for hundreds of immediate "off-the-shelf" answers to specific interconnect requirements.

That's what you expect from us. After all, we do have one of the most extensive OEM connector lines in the business.

But give us an "early" call—while you're still designing your product—and see what happens. You get more than you bargained for.

First of all, you get the combined talents of a team of experts made up of specialists in connector technology, quality control, assembly techniques and delivery operations. When they attack an interconnect requirement, they mean business. They look at the total picture. Product design. Assembly operations. Inventory requirements. The bottom line. Everything!

Result? You get a total interconnect solution instead of just a connector. And whether it's an "off-the-shelf" connector or a totally new design, it almost always means lower installed costs. Improved product quality. Reduced inventory requirements and fewer inspection requirements. Little things like that can have a big influence on your bottom line.

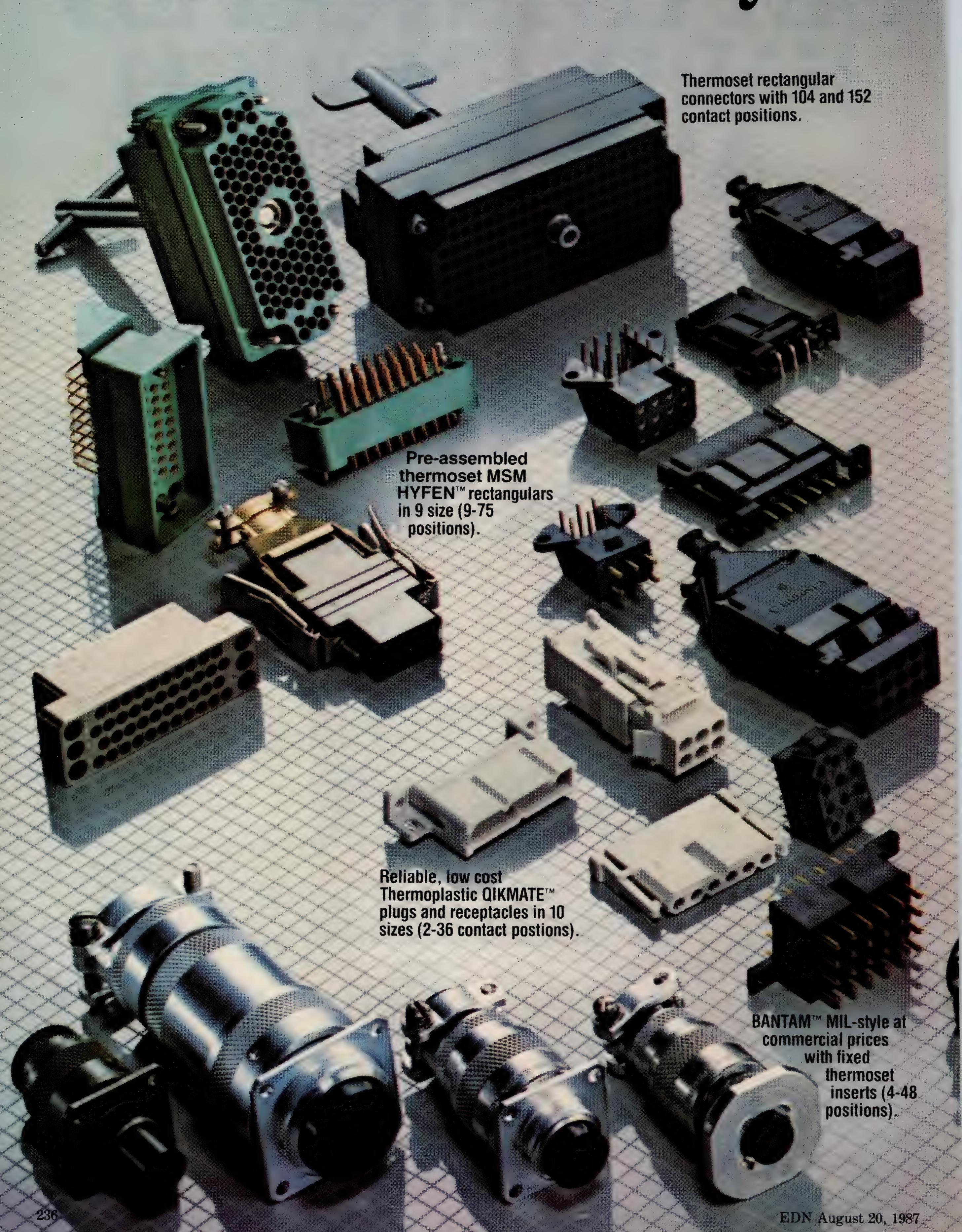
So let's get involved. Early. Make us a part of your design team—and you'll get more than you bargained for. The nice thing about it is that it may actually cost you less in the final analysis. Just call: 1-800-633-0034 (Ext. 25), in Rhode Island: 401-751-7450. See how fast we respond.

BURNDY

Offices in principal cities throughout the United States

VALUE BY DESIGN

# The one interconnect system



# you never outgrow!

# TrimTrio™

## Single contact system satisfies over 100,000 interconnect variations.

Designed for maximum flexibility, proven in millions of applications—Burndy's TRIM-TRIO contact/connector family lets you meet all your application needs—no matter how often they change—without changing your contact system! Your tooling! Or your installation procedures!

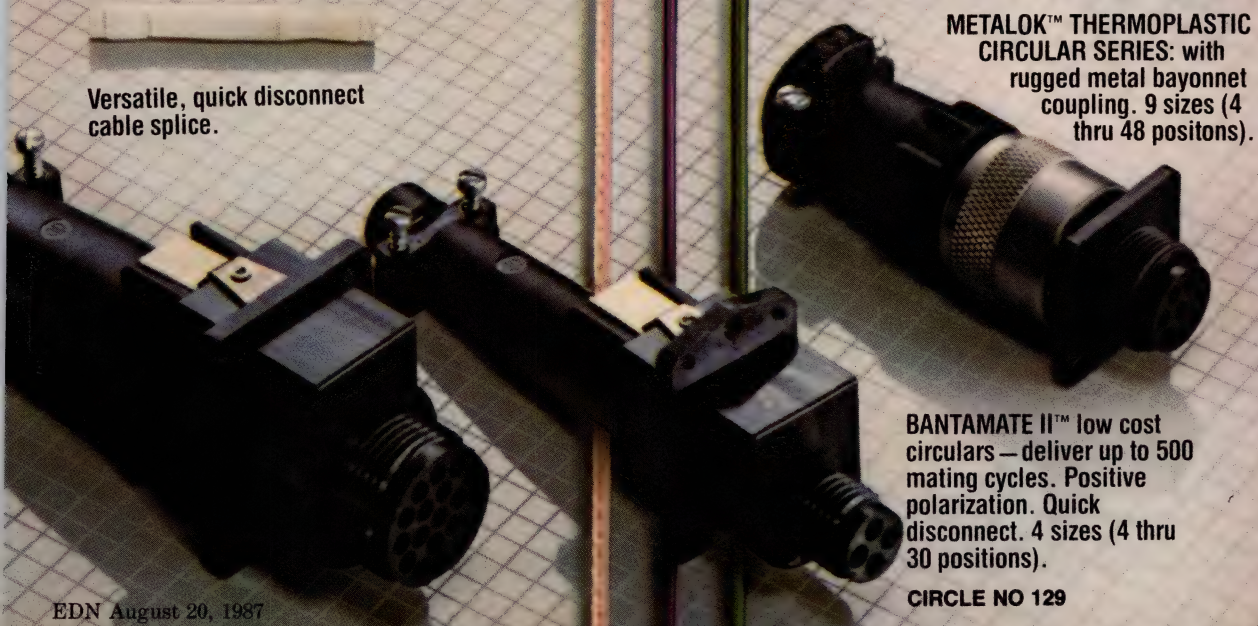
You simply select the contact/housing combination that best satisfies your current needs. Then, as needs change, you just change the combinations. Nothing else! Not your tooling! Not your operations. Nothing! And no matter what combination you choose—or how many—you still enjoy all the advantages of standardization. Which means faster, more economical assembly and greater quality control—all along the line.

So make it easy on yourself. Standardize on the proven reliability of the Burndy TRIM-TRIO interconnect system. The one system that offers you thousands of variations. The one system you'll never outgrow. And to make things easier, all variations of the TRIM-TRIO family are available—off the shelf—at your local Burndy Distributor. For details, write: Burndy Corporation, TRIM-TRIO Product Manager, Norwalk, CT 06856. Or call: 203-852-8711.

**THE TRIM-TRIO CONTACTS SYSTEM: Closed barrel Machined Contacts** for both crimp and wire-wrap power applications up to 13 amps. **Open barrel Precision Formed** contacts for power and signal applications. **Sub-miniature Coax** (one-piece or 2-piece) for coaxial cable, shielded conductors and twisted pairs. These three basic types (with variations for different conductors, contact platings and termination options) make up the TRIM-TRIO contact system. All can be intermixed in any of scores of Burndy connector housings designed around this contact system.

BURNDY

Offices in principal cities throughout the United States.



Versatile, quick disconnect cable splice.

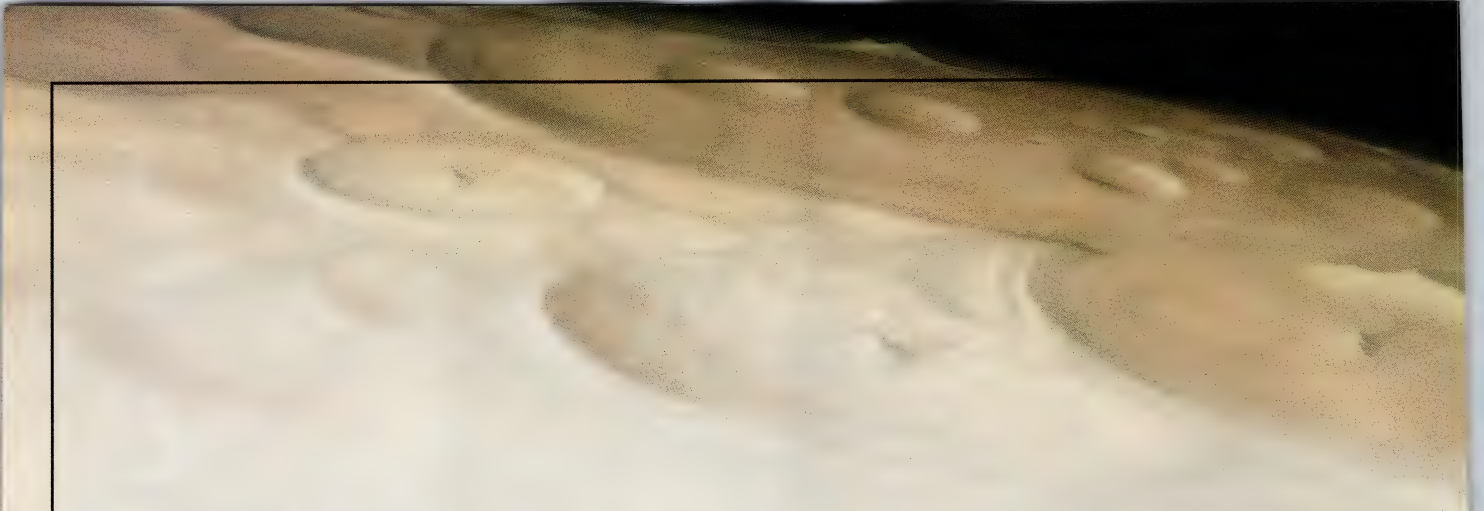
METALOK™ THERMOPLASTIC CIRCULAR SERIES: with rugged metal bayonnet coupling. 9 sizes (4 thru 48 positons).

BANTAMATE II™ low cost circulars—deliver up to 500 mating cycles. Positive polarization. Quick disconnect. 4 sizes (4 thru 30 positions).

CIRCLE NO 129

BURNDY CONNECTS

INTERNATIONAL SALES AND MANUFACTURING: BRUSSELS, BARCELONA, PARIS, ROTTERDAM, STOCKHOLM, STUTTGART, TURIN, ZURICH, ST. ALBANS (ENG.), TORONTO, SYDNEY, TOKYO, MEXICO CITY, SAO PAULO.



# America, Harris will meet your rad-hard needs in the future...just as we have for 20 years past.

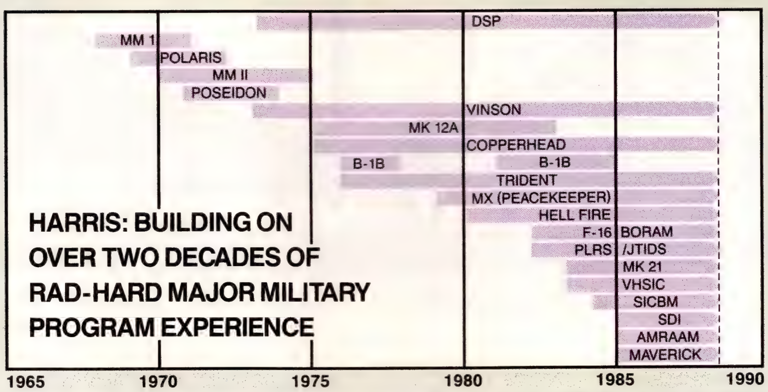

**American ICs for American strength...** That's been our commitment since 1965. And today we're the number-one supplier of rad-hard ICs for military systems.

Harris ICs perform in the most critical environments. For SDI and the programs requiring state-of-the-art technology, we're developing even higher-performance products — in both **silicon and gallium arsenide.**

Some IC companies have uncertain futures. We don't. We'll be here. American-owned and American-run. Providing products and product accountability throughout the lifetime of your systems.

**We wrote the book on your future needs.** It's Harris' 1987 Rad-Hard/Hi-Rel Data Book: hundreds of pages of information on what's here now and what's coming next. Ask for a copy.

Contact: Harris Semiconductor Sales Ltd., Eskdale Road, Winnersh, Wokingham, Berks, RG11 5TR England.


# IN RAD-HARD/HI-REL, THE NAME IS HARRIS

Harris Semiconductor: Analog - CMOS Digital
Gallium Arsenide - Semicustom - Custom

HARRIS

CIRCLE NO 128


These High-Rel SRAMs offer you all these benefits:

- 100 ns access time at 25°C
- Low standby current: 1 mA typical
- Full Mil temperature range
- 32Kx8 organization
- 28 Terminal DIL Package
- Screened to Mil-Std-883 Class B.* So they're perfect for use in a wide range of military systems. And, as you'd expect from the leaders in High-Rel CMOS, we have a full line of SRAMs, including 64K (8Kx8) and 16K (2Kx8).

**Tops in Rad-Hard RAMs, too.**

If you need rad-hardness, remember that we offer 1K, 4K and 16K CMOS/SOS RAMs as well.

Our Rad Hard 16Kx1 CMOS/SOS RAM has an access time of 125 ns at 25°C and is available for immediate delivery to Class S type specifications.

CMOS/SOS is the ideal technology for rad-hard applications because:

- It's latch-up free under transient radiation
- It's highly tolerant to single-event upset caused by radiation (typically $2 \times 10^{-9}$ errors/bit/day)
- It has total dose tolerance from 100K RADs to "MEGARAD."

**We know, because we invented CMOS/SOS.**

So whatever your needs in SRAMs, aim high, and call the Top Guns today.

For additional information, call toll-free 800-443-7364, extension 20. Or contact your local GE/RCA sales office or distributor.

*Rev. C, Paragraph 1.2.2

RCA



In Europe, call: Brussels, (2) 246-21-11; Paris, (1) 39-46-57-99; London, 0276-685911; Milano, (2) 82-291; Munich, (89) 63813-0.

# SHHHHHH.

## 1 nV/$\sqrt{\text{Hz}}$ OP AMP AT WORK.

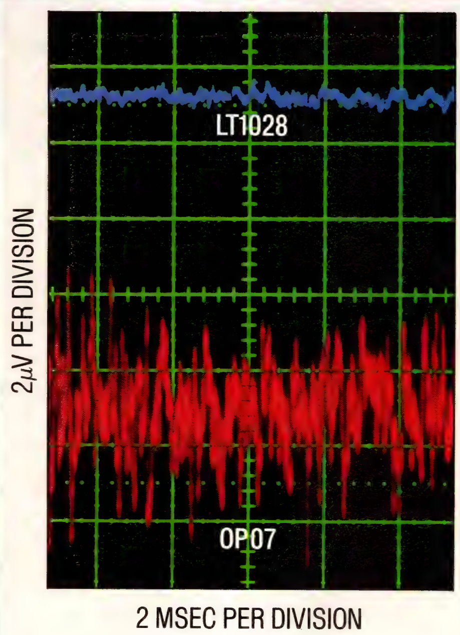
*Quiet Please.*

Introducing the LT1028, our new ultra-low noise, precision, high-speed op amp that combines unprecedented low-noise voltage with high-speed and precision DC specifications.

The LT1028's wideband noise density is 0.85 nV/$\sqrt{\text{Hz}}$, *less than the noise of a 50Ω resistor.* The LT1028 is three times better than the previous leaders (our own LT1007 and LT1037). Even at 10Hz, voltage noise only rises to a mere 1.0nV/$\sqrt{\text{Hz}}$. Further, we 100% test voltage and current noise, and guarantee 1 kHz voltage noise at 1.1nV/$\sqrt{\text{Hz}}$ maximum.

Slew rate is guaranteed at 11V/μsec, and gain-bandwidth at 50 MHz.

The LT1028 also excels in DC specs: 40μV maximum offset voltage, and 0.8μV/°C maximum drift. Voltage gain is guaranteed at 7 million, *the highest of any op amp.* This high gain, combined with the wide bandwidth, means that a gain in excess of 3 million can be achieved up to 30 Hz. Compare this to other "million-gain" op amps where the gain falls below 3 million above 0.2 Hz, if the signal processed changes faster than once every five seconds.




The LT1028 is 12-times less noisy than the OP07, the standard for low-noise op amps.

Typical applications for this ultra-low noise op amp include low-noise frequency synthesizers and phase-lock loops, high-quality audio, accelerometer and gyro amplifiers, infrared detectors, magnetic search coil and hydrophone amplifiers. Even in low source impedance transducer or audio amplifier applications, the LT1028's contribution to total system noise is negligible.

If you're ready to enter *The Quiet Zone,* ask about our LT1028 (or our LT1037 and LT1007 op amps). Pricing for the LT1028 family starts at $4.95 for the LT1028CN8 (in quantities of 100). This device is available in commercial and military temperature ranges and meets MIL-STD-883 specifications. For details, contact: LINEAR TECHNOLOGY CORPORATION, 1630 McCarthy Blvd., Milpitas, CA 95035. **800-637-5545.**

LINEAR TECHNOLOGY

TOUGH PRODUCTS
FOR TOUGH APPLICATIONS.

**CIRCLE NO 125**

# Power-MOSFET IC drives pin diodes


Steve Andrezyk
*GE/RCA/Intersil, Newton Lower Falls, MA*


**Fig 1**'s circuit uses a dual power-MOSFET IC, normally found in motor controllers and switching power supplies, to drive pin diodes in an RF switch. *(Ed Note: In switch applications, a pin diode offers better off-state performance than a conventional diode. A pin diode's middle layer of intrinsic silicon widens the depletion layer, which increases the diode's dynamic resistance and reduces its junction capacitance.)*

In this circuit, three pin diodes in parallel provide a shunt to ground for each of the two 10-GHz transmission lines. Applying reverse bias to the diodes closes the switch by allowing RF to pass through. Forward bias opens the switch by shunting the RF frequency to ground.

Applying 8.3 mA per diode (25 mA per switch) forward-biases the pin diodes, but the driver must also supply a pulse of current to quickly discharge the diodes' intrinsic-silicon regions. The continuity equation $dQ/dt=-(Q/T_L+I_R)$ describes the removal of charge from the intrinsic region. $T_L$ is the carrier lifetime within the diode, and $I_R$ is the externally applied reverse current. Thus, a driver with current-pulse capability can improve a pin diode's turn-off time.

The driver outputs of $IC_1$ can deliver 1.5A pk; the capacitors shown ($C_3$ and $C_6$) allow 600-mA current pulses to the pin diodes. Similarly, resistors $R_2$ and $R_4$ set the steady-state current, $I_F$, at 25 mA. Because $IC_1$'s TTL-compatible inputs reference the $V^-$ terminal (pin 3), the circuit includes voltage-translation networks: $D_1/R_1$ and $D_2/R_3$. These networks allow open-collector LSTTL signals to drive the chip while operating with $V^-$ at $-10V$.

The propagation delay between the TTL input command and the RF output (which you detect using a crystal) measures 48 nsec for forward bias and 55 nsec for reverse bias. The circuit can switch at rates to 1 MHz. **EDN**

**To Vote For This Design, Circle No 748**

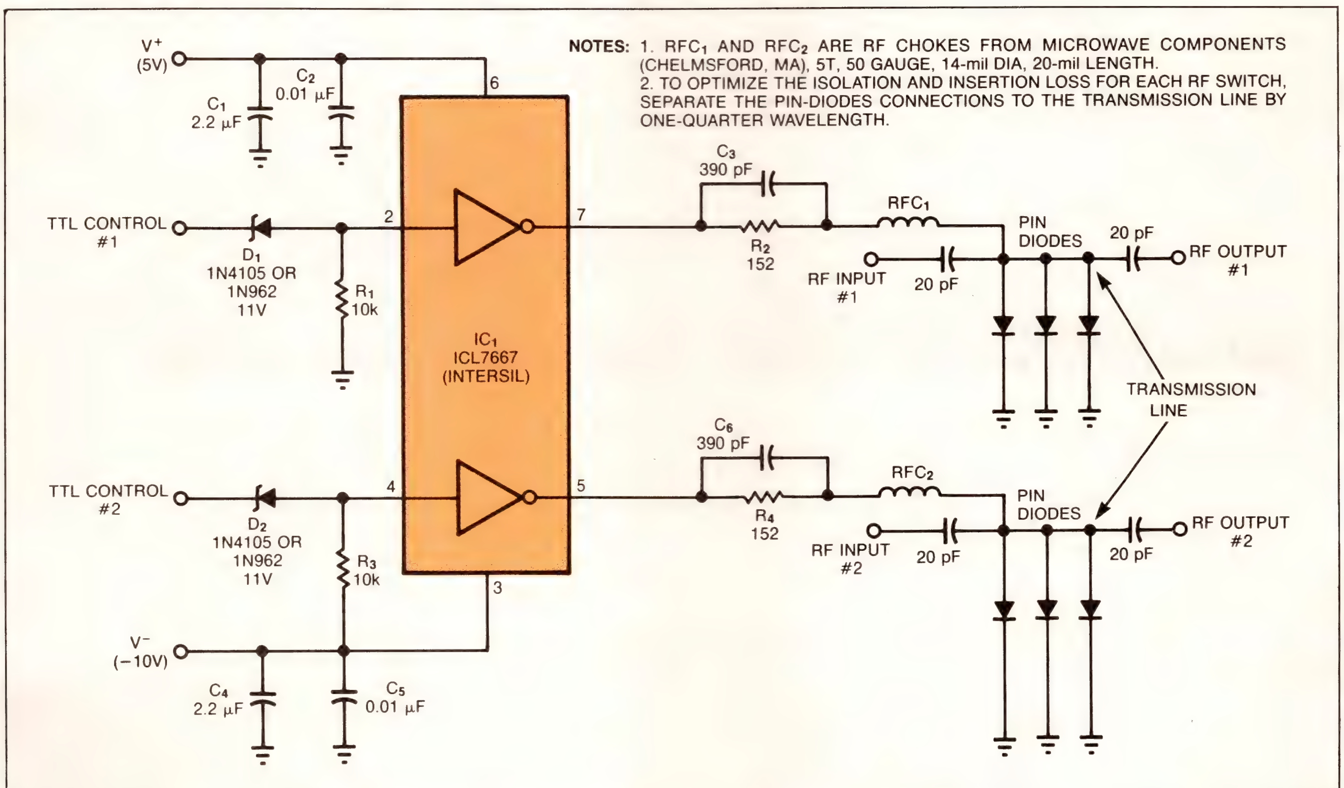



***Fig 1—This dual RF switch, based on an inexpensive power-MOSFET chip** and pin-diode switching elements, offers approximate 50-nsec propagation delays and a maximum 1-MHz switching rate.*

# Subroutine plots data from Basic programs

Brown Porter Jr
*Unisys Corp, Bristol, TN*

**Listing 1,** a graphics subroutine for the IBM PC, is capable of plotting a graph of the data generated by your Basic program, using any or all quadrants of the Cartesian plane. It gives you scale options of linear, semilog (X or Y axis), or log-log (one to five cycles); it provides automatic ranging and scaling; and it lets you set the Y scale, typically from ¼ to a full page (2½ to 10 in.). It also prints the title, subtitle, and scale labels in text mode, using upper- and lower-case characters.

**LISTING 1—GRAPHICS SUBROUTINE**

```
1000 '~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
1010 '     **** PLOT1 S/R ****
1020 '
1030 HT%=15                                        'Set height of graph
1040 CLS: KEY OFF
1050 DIM A$(62), B$(62)
1060 GOSUB 2120                                    'Define plot char S/R
1070 IF (XSCALE$="G") OR (XSCALE$="g") THEN 1080 ELSE 1120
1080 GOSUB 1790                                    'Scale X S/R
1090 IF (YSCALE$="G") OR (YSCALE$="g") THEN 1100 ELSE 1120
1100 GOSUB 1860                                    'Scale Y S/R
1110 '  --- Find Min and Max ---
1120 FOR N=1 TO AP
1130   IF N<>1 THEN 1160
1140   XMAX=X(1): XMIN=X(1): YMAX=Y(1): YMIN=Y(1)        'Intl regs
1150   GOTO 1240
1160   IF XMAX>=X(N) THEN 1180                     'Find Xmax
1170   XMAX=X(N)
1180   IF XMIN<X(N) THEN 1200                      'Find Xmin
1190   XMIN=X(N)
1200   IF YMAX>=Y(N) THEN 1220                     'Find Ymax
1210   YMAX=Y(N)
1220   IF YMIN<Y(N) THEN 1240                      'Find Ymin
1230   YMIN=Y(N)
1240 NEXT N
1250   FOR I=1 TO N
1260     Y(I)=Y(I)-YMIN                            'Translate all X & Y values
1270     X(I)=X(I)-XMIN                            'to avoid negative numbers
1280   NEXT I
1290 XDIV=60/(XMAX-XMIN): YDIV=HT%/(YMAX-YMIN)   'Calculate scale factors
1300 XAXIS%=HT%-YMAX*YDIV: YAXIS%=INT(.5-XMIN*XDIV)      'Locate axes
1310 PRINT YUNIT$
1320 GOSUB 2050                                    'Print top border
1330 '  --- Build Image Line ---
1340 FOR I=1 TO 60
1350   IF I<>YAXIS% THEN 1380                      'Y axis ?
1360   A$(I)="+"                                   'Yes
1370   GOTO 1390
1380   LET A$(I)=" "                               'no
1390 NEXT I
1400 IF HT%<>XAXIS% THEN 1420                      'X axis ?
1410 FOR I=1 TO 60: A$(I)="-": NEXT I              'Yes
1420   FOR I=1 TO N
1430     IF Y(I)<=(HT%-.5)/YDIV THEN 1470          'Value Y(I) = line value?
1440     K%=X(I)*XDIV                              'Yes; find X location
1450     A$(K%)=CURVE1$                            '"*"
1460     Y(I)=-Y(I)
1470   NEXT I                                      'No
1480 A$(61)=YBORDER$                               'Right boundry
1490 V=YMIN+HT%/YDIV
1500 IF (YSCALE$="G") OR (YSCALE$="g") THEN 1510 ELSE 1520
1510 GOSUB 1930
1520 IF HT%/5<>INT(HT%/5) THEN 1560                'Print every fifth line
1530 GOSUB 1970                                    'Label axis
1540 PRINT TAB(10); YBORDER$;"-";                  '"I-"
1550 GOTO 1570
1560 PRINT TAB(10); YBORDER$;" ";                  'Print non label lines
1570 FOR I=1 TO 61: PRINT A$(I);: NEXT I           'Print image line
1580 PRINT
1590 HT%=HT%-1                                     'Next line
1600 IF HT%>=0 THEN 1340                           'Finished plotting?
```

Listing continued on pg 246

from

# 99¢

# dc to 2000 MHz amplifier series

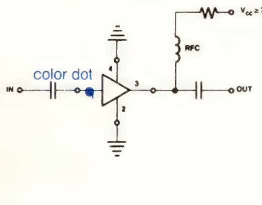
## SPECIFICATIONS

| MODEL | FREQ. MHz | GAIN, dB 100 MHz | 1000 MHz | 2000 MHz | Min. (note) | •MAX. PWR. dBm | NF dB | PRICE $ Ea. | Qty. |
|---|---|---|---|---|---|---|---|---|---|
| MAR-1 | DC-1000 | 18.5 | 15.5 | — | 13.0 | 0 | 5.0 | 0.99 | (100) |
| MAR-2 | DC-2000 | 13 | 12.5 | 11 | 8.5 | +3 | 6.5 | 1.50 | (25) |
| MAR-3 | DC-2000 | 13 | 12.5 | 10.5 | 8.0 | +8□ | 6.0 | 1.70 | (25) |
| MAR-4 | DC-1000 | 8.2 | 8.0 | — | 7.0 | +11 | 7.0 | 1.90 | (25) |
| MAR-6 | DC-2000 | 20 | 16 | 11 | 9 | 0 | 2.8 | 1.29 | (25) |
| MAR-7 | DC-2000 | 13.5 | 12.5 | 10.5 | 8.5 | +3 | 5.0 | 1.90 | (25) |
| MAR-8 | DC-1000 | 33 | 23 | — | 19 | +10 | 3.5 | 2.20 | (25) |

NOTE: Minimum gain at highest frequency point and over full temperature range.
• 1dB Gain Compression
□ +4dBm 1 to 2 GHz

## designers amplifier kit, DAK-2

5 of each model, total 35 amplifiers
only $59.95




Unbelievable, until now...tiny monolithic wideband amplifiers for as low as 99 cents. These rugged 0.085 in.diam.,plastic-packaged units are 50ohm* input/output impedance, unconditionally stable regardless of load*, and easily cascadable. Models in the MAR-series offer up to 33 dB gain, 0 to +11dBm output, noise figure as low as 2.8dB, and up to DC-2000MHz bandwidth.

*MAR-8, Input/Output Impedance is not 50ohms, see data sheet.
Stable for source/load impedance VSWR less than 3:1

Also, for your design convenience, Mini-Circuits offers chip coupling capacitors at 12 cents each.†

| Size (mils) | Tolerance | Temperature Characteristic | Value |
|---|---|---|---|
| 80 × 50 | 5% | NPO | 10, 22, 47, 68, 100, 470, 680, 100 pf |
| 80 × 50 | 10% | X7R | 2200, 4700, 6800, 10,000 pf |
| 120 × 60 | 10% | X7R | .022, .047, .068, .1μf |

† Minimum Order 50 per Value

finding new ways ...
setting higher standards

**Mini-Circuits**

A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Fax (718) 332-4661 Domestic and International Telexes: 6852844 or 620156

**CIRCLE NO 140**

C113-Rev. D

### LISTING 1—GRAPHICS SUBROUTINE *(Continued)*

```
1610    FOR I=1 TO 7                                  'Yes
1620      PRINT TAB(I*10+2); YBORDER$;                'Print X axis divisions
1630    NEXT I
1640 GOSUB 2050                                       'Print bottom border
1650    FOR I=0 TO 6
1660      V=XMIN+I*10/XDIV
1670      IF (XSCALE$="G") OR (XSCALE$="g") THEN 1680 ELSE 1690
1680      GOSUB 1930
1690      PRINT TAB(I*10+9);                          'Print X labels
1700      GOSUB 1970
1710    NEXT I
1720 PRINT: PRINT: PRINT TAB(27) XUNIT$
1730 PRINT: PRINT: PRINT TAB(27) TITLE$: PRINT
1740 PRINT TAB(27) SUBTITLE$
1750 RETURN
1760 END
1770 '
1780     --- LOG SCALE X S/R ---
1790 FOR I=1 TO AP:X=X(I)
1800 ON SGN(X)+2 GOTO 2170,2190,1810
1810 X=LOG(10*X)/LOG(10): IF X<0 THEN 2210
1820 X(I)=X: NEXT I
1830 RETURN
1840 '
1850 '   --- Log Scale Y S/R ---
1860 FOR I=1 TO AP: Y=Y(I)
1870 ON SGN(Y)+2 GOTO 2170,2190,1880
1880 Y=LOG(10*Y)/LOG(10): IF Y<0 THEN 2210
1890 Y(I)=Y: NEXT I
1900 RETURN
1910 '
1920 '   --- Log Scale Label S/R ---
1930 V=10^V/10
1940 RETURN
1950 '
1960 '   --- Axes Labeling S/R ---
1970 IF V<>0 THEN 1980: PRINT V; GOTO 2020
1980 IF V>99 THEN 2010
1990 IF V<0!-99 THEN 2010
2000 PRINT USING "###.##";V;: GOTO 2020
2010 PRINT USING "##.##^^^^";V;
2020 RETURN
2030 '
2040 '   ---   Border S/R   ---
2050 FOR I=1 TO 61: B$(I)=XBORDER$ : NEXT I       'Fill top/bot border
2060 PRINT TAB(11);
2070 FOR I=1 TO 61: PRINT B$(I);: NEXT I          'Print top/bot border
2080 PRINT
2090 RETURN
2100 '
2110 '   --- Plot Char. Table ---                 IBM      Star     Epson
2120 XBORDER$=CHR$(196)                           '196     241      133
2130 YBORDER$=CHR$(179)                           '179     245      134
2140 CURVE1$ =CHR$(254)                           '254     239      147
2150 RETURN
2160 '
2170 PRINT"Negative numbers are illegal on log scales."
2180 GOTO 995
2190 PRINT"Zero is illegal on log scales."
2200 GOTO 995
2210 PRINT"This program will plot log scales down to 0.1 with printing resolutio
n.  Units  smaller then 10^-1 should be converted to milli, micro etc. to preser
ve plotting accuracy."
2220 GOTO 995
```

The subroutine has minimal impact on your main program, and it precludes the necessity of writing a special plotting routine, or of trying to visualize a curve by looking at a list of output data. **Listing 2** is an example of how the subroutine operates in a short program. The program includes a For/Next loop that generates discrete points on a continuous, 2-dimensional curve called a strophoid.

You establish an X-Y array (lines 30 and 900 to 915), select linear or log scales (lines 920 and 930), and then provide the title and scale labels (lines 940 to 970). To center the titles, add or subtract spaces between the quotation mark and the first character. The graph's vertical dimension depends on line 1030 (HT%=nn) in **Listing 1.** The variable "nn" lets you size charts for inclusion in technical reports; 15 is a good size for screen viewing, and 30 is a good starting value for printing.

As you can see, the subroutine displays the graph on a monitor. Using the echo print method, you can make a

ZILOG

# Z280

# The highest performance and highest integration, ever. Together on a single 16-bit chip.

The Z280™ gives you a more powerful CPU and higher performance peripherals than you've ever seen on a 16-bit chip. Think of it as a complete microsystem on a chip.

## Unmatched performance...

Start with the most powerful 16-bit engine available, add on-board Cache, MMU and Burst Mode memory support — and you'll begin to understand the Z280's power and potential.

## ...powerful on-board peripherals...

Imagine the savings in cost and board size when you have peripherals like 4 DMA channels that'll give you transfers at 6.6 Mbytes/sec, and a full-duplex UART.

| | Z280™ | 80186 | 68070 |
|---|---|---|---|
| Package | 68-pin PLCC/CMOS | 68-pin LCC/NMOS | 84-pin PLCC/CHMOS |
| Typical Power | 375 mW | 2 W | 800 mW (est) |
| Speed | 10-25 MHz | 8-12.5 MHz | 10 MHz |
| Memory Support | 16 Mb Physical Paged | 1 Mb Physical Segmented | 16 Mb Physical 8 or 128 Segments |
| 16-bit Registers | 12 General | 8 General | 15 Dedicated |
| Instruction Pre-fetch | 256-Byte Assoc. Cache; Burst Mode | 6-Byte Queue | None |
| Multiprocessor Support | Local or Global | Local only | Local only |
| Wait Logic | Programmable | Programmable | Hardwire |
| DMA | 4 Channels, 6.6 Mb/s @ 10 MHz | 2 Channels 2 Mb/s @ 8 MHz | 2 Channels, 3.2 Mb/s @ 10 MHz |
| Counter/Timers | 3 16-bit | 3 16-bit | 2 16-bit |
| Serial I/O | 1 Full-Duplex UART | None | 1 Full-Duplex UART |
| DRAM Controller | 10-bit Refresh | None | None |
| Price (100) | $33 | $43 | $50 |

## The choice is clear.

## ...and the glue to tie it all together.

With a DRAM Controller to support up to 1 MBit DRAMs and Programmable Wait State Logic — on board — you're really looking at significant glue reduction.

## Z280: Truly a microsystem.

The Z280 gives you a lot more performance. In a lot less board space. All off the shelf and backed by Zilog's proven quality and reliability. Plus, it's binary code-compatible with the Z80,® and priced to rival 8-bit chips. And all the development support tools you need are available from industry leaders. Contact your local Zilog sales office or your authorized distributor today. Seeing is believing. Zilog, Inc., 210 Hacienda Ave., Campbell, CA 95008 (408) 370-8000.

## Right product. Right price. Right away.

**ZILOG SALES OFFICES: CA** (408) 370-8120, (714) 432-9971, (818) 707-2160, **CO** (303) 494-2905, **FL** (813) 585-2533, **GA** (404) 923-8500, **IL** (312) 885-8080, **MA** (617) 273-4222, **MN** (612) 831-7611, **NJ** (201) 288-3737, (609) 778-8070, **OH** (216) 447-1480, **TX** (214) 231-9090, **CANADA** Toronto (416) 673-0634, **ENGLAND** Maidenhead (44) (628) 781227, **W. GERMANY** Munich (49) (89) 612-6046, **JAPAN** Tokyo (81) (3) 587-0528, **HONG KONG** Kowloon (852) (3) 723-8979. **R.O.C.:** Taiwan (886) (2) 731-2420, **U.S. AND CANADA DISTRIBUTORS:** Anthem Electric, Bell Indus., Graham Elec., Hall-Mark Elec., JAN Devices Inc., Lionex Corp., Schweber Elec., Western Microtech., **CANADA** Future Elec., SEMAD.

Zilog
an affiliate of
EXXON Corporation



CIRCLE NO 153

Time is of the essence. The essence of the HP DraftMaster Plotter. The fastest A to E size drafting plotter made by Hewlett-Packard. A plotter so fast, any designer can create big ideas at blinding speeds.

How did we do it? With unsurpassed acceleration. And features like a new pen-sorting algorithm. Bi-directional plotting. And a very fast resident micro-processor. We even offer a model with roll-feed for non-stop plotting.

But the HP DraftMaster doesn't sacrifice output quality for its blinding speed. Every plotter is thoroughly tested to ensure the highest reliability and precision. So you get smooth arcs, straight lines and perfectly-formed characters, time after time. Furthermore, it handles a variety of pens on drafting film, vellum or paper—all at optimal speeds.

Naturally, it works with just about any computer. Like the HP Vectra PC and IBM PC's. As well as popular PC-CAD software like AutoCAD and VersaCAD. And the DraftMaster brings with it HP's worldwide reputation for quality. Prices start at just $9,900.*

Why wait? For a brochure and a sample plot, call us at **1 800 367-4772,** Ext. 901A.

The drawing shown below was produced on the HP DraftMaster with AutoCAD software.

**HEWLETT PACKARD**

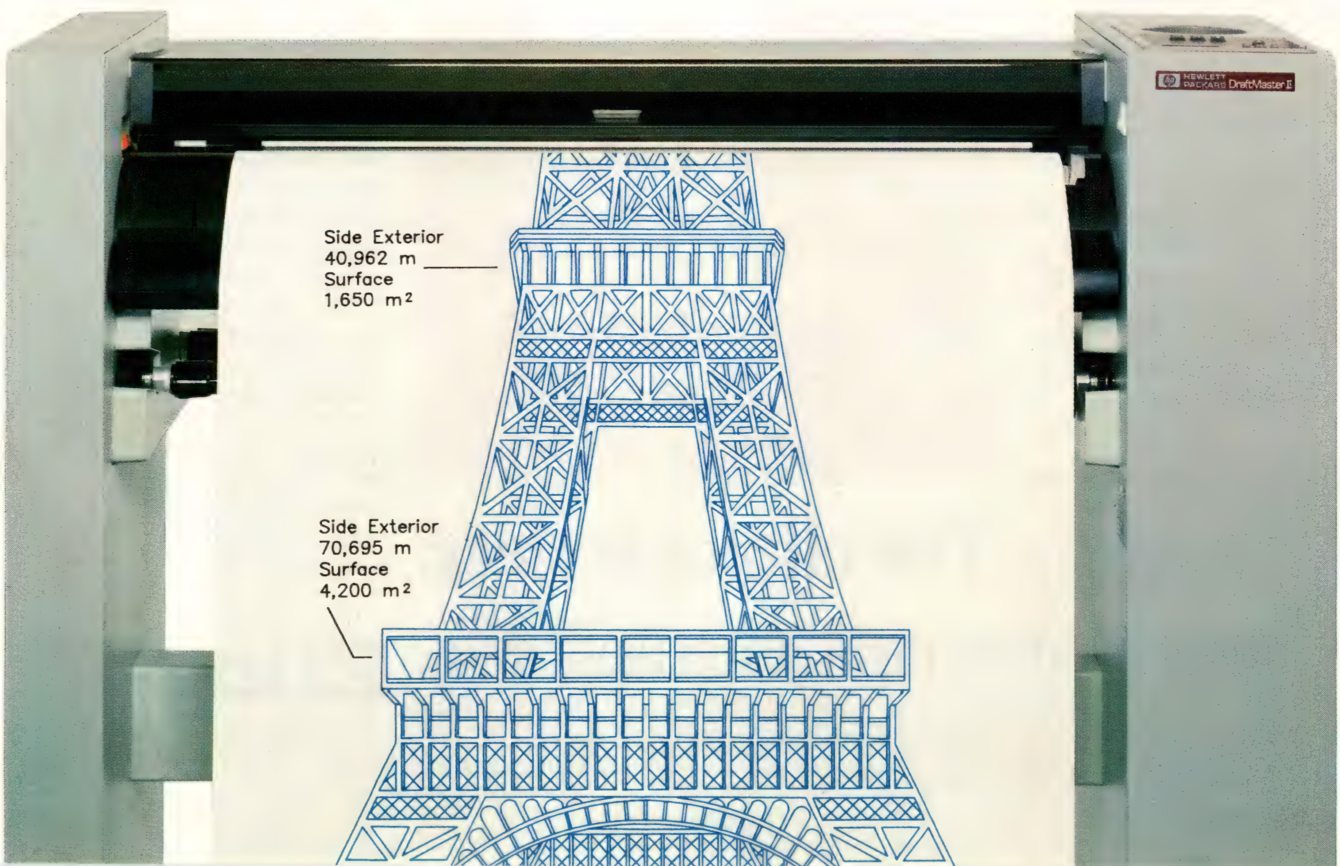
AutoCAD is a registered trademark of AutoDesk Inc. VersaCAD is a registered trademark of T&W Systems. *Suggested U.S. list price.
© 1987 Hewlett-Packard Co. PE12703

**CIRCLE NO 152**

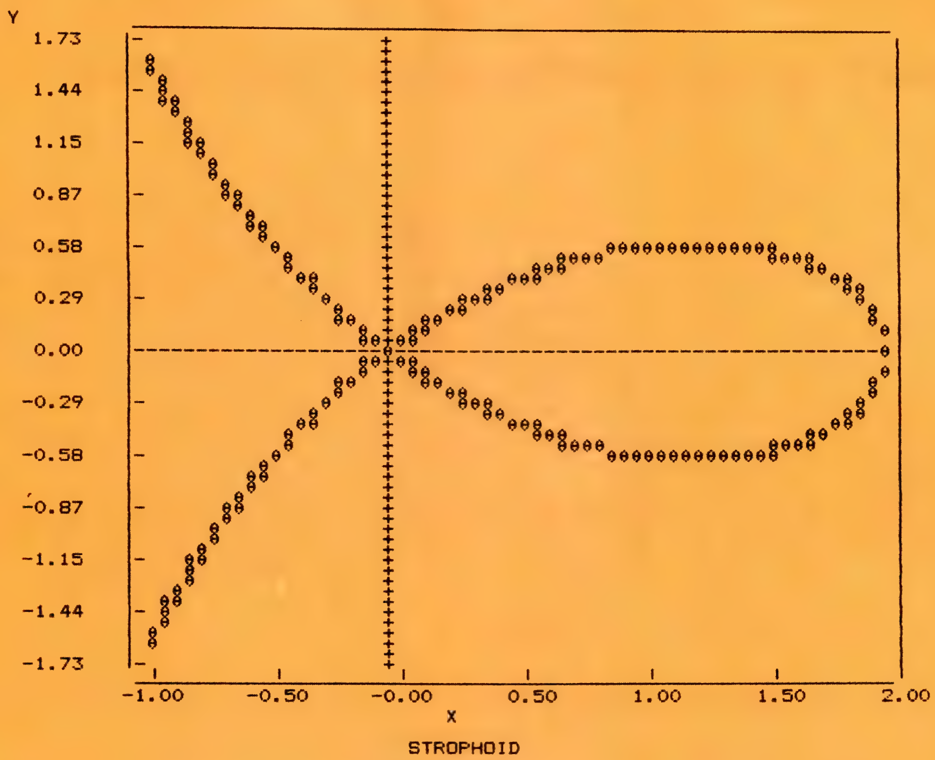
*we never stop asking*

*What if...*

# How to create monumental plots in a matter of minutes.



## LISTING 2—SAMPLE PROGRAM




```
Ok
10 '    >>> STROPHOID <<<
20 '~~~~~~~~~~~~~~~~~~~~~~~~~~
30 DIM X(500),Y(500) : AP=0
100     FOR X=-1 TO 4 STEP .02
110     A=(2-X)/(2+X)
120     IF A<0 THEN 915
130     Y=SQR(X^2*A)
900     AP=AP+1
902     X(AP)=X
904     Y(AP)=Y
906     AP=AP+1
908     X(AP)=X
910     Y(AP)=0-Y
915     NEXT X
920 XSCALE$= "L"                                   'Linear(L) or Log(g)
930 YSCALE$= "L"                                   'Linear(L) or Log(g)
940 TITLE$=    "         STROPHOID              "
950 SUBTITLE$="                                 "
960 YUNIT$=    "Y       "
970 XUNIT$=    "           X                    "
980 '
990 GOSUB 1000
995 END
```

hard copy by pressing Ctrl and then pressing PrtSc (Fn, Echo on the IBM Jr) and then running the program. Don't forget to clear the echo mode by repeating this key sequence after the printing is finished. If you don't want or need to preview the graph on the screen, change all PRINT statements to LPRINT ones, which route the output directly to the printer.

To use different printers or change the appearance of your graph, look up the special characters for plotting the curve and borders, which you can find at line 2110 in **Listing 1.** If you're using a printer that doesn't have an IBM mode, and therefore inserts unwanted spaces in the vertical borders, try adding lines 1052, 1054, and 1745:

```
1052 PRINT CHR$(27);"@"              'Clear printer presets
1054 PRINT CHR$(27);"A";CHR$(6)      'Print W/O spaces
1745 PRINT CHR$(27);"@"              'Return printer to text mode
```

If this doesn't work, you'll have to consult your printer manual for a command that allows printing without spaces. **EDN**

**To Vote For This Design, Circle No 750**

# Proximity sensor is battery operated

Gary S Kath and Greg King
*Merck and Co Inc, Rahway, NJ*

The unconventional use of a smoke-detector IC makes possible the noncontact, battery-operated proximity sensor of **Fig 1.** (The circuit was developed to detect the loss of airflow by monitoring the position of a paper vane.) $IC_1$ controls a piezoelectric horn, $PZ_1$, sounding an alarm when the reflective target disappears or when the battery voltage is low.

$IC_1$ includes an oscillator timer, a low-battery latch, a smoke latch, and a piezoelectric-horn driver. Components $R_1$ and $C_1$ determine the oscillator timer's frequency; the values shown produce a period of about 1.7 sec. Every 40 sec (24 timer periods), the chip activates the LED for 10 msec.

LED light reflected from the target illuminates phototransistor $Q_1$, causing it to conduct and deliver a negative pulse to the NAND-gate network. This action produces a logic-high output from latch $IC_3$. The latch output goes low if the target isn't present, prompting $IC_1$ to activate the horn for the next 40 seconds. If the target is in place during the next LED pulse, $Q_1$ will conduct and turn off the horn.

Each time the LED turns on and loads the 9V battery, $IC_1$ compares the battery voltage to that of an internal zener reference. If the comparison reveals a low battery, the chip directs brief chirps from the piezoelectric horn. The LED's low duty cycle produces an average battery drain of only 10 μA in the absence of an alarm. **EDN**

**To Vote For This Design, Circle No 749**

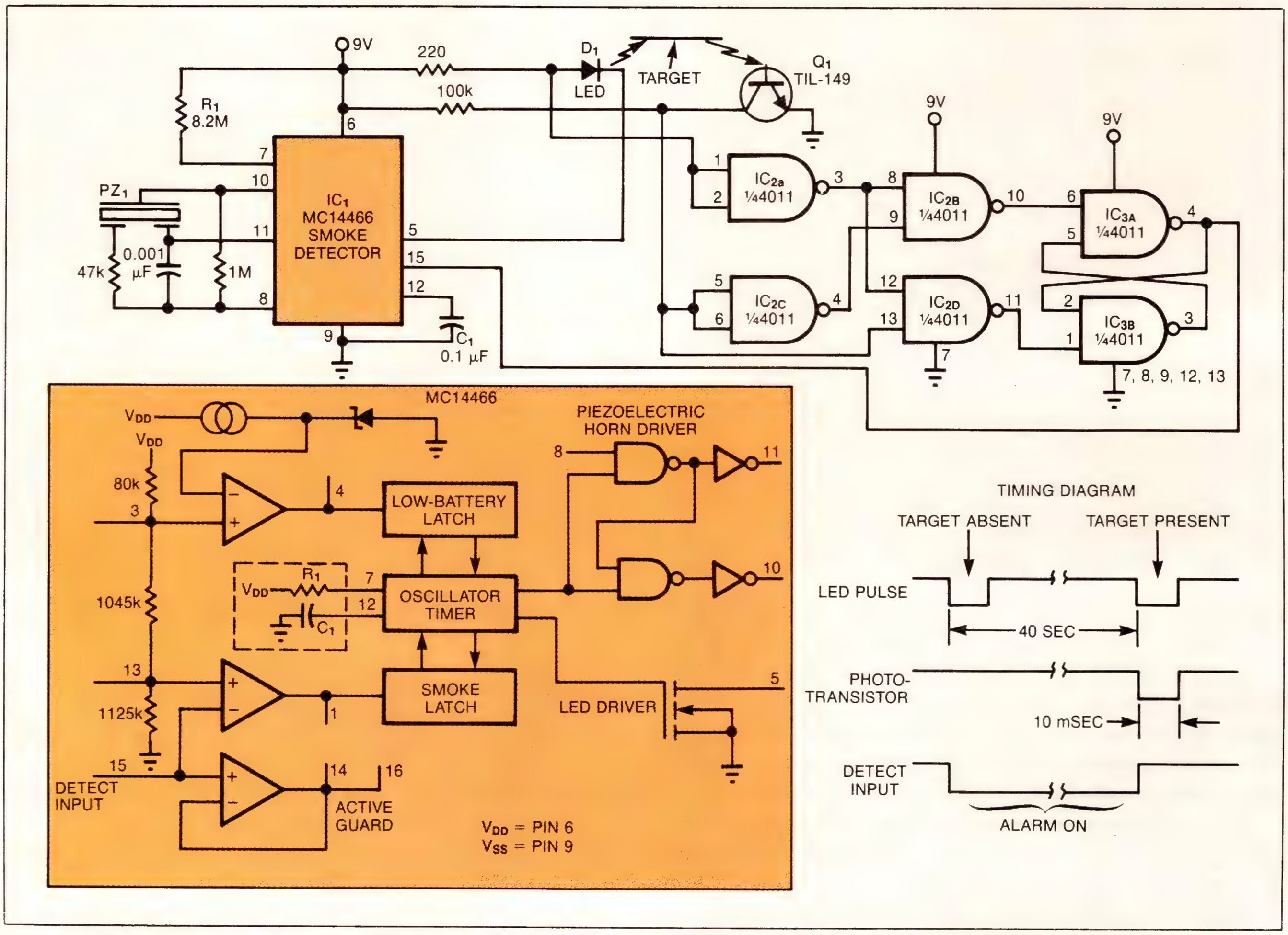
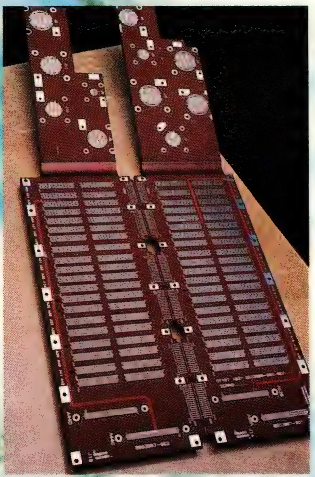



*Fig 1—**This sensor uses reflected light** to indicate the presence or absence of a target, and it includes a piezoelectric horn to warn of an absent target or of low battery voltage.*

# Performance
BEHIND THE CLOUDS/BEYOND THE STARS
# Begins Here.



The performance of sophisticated military electronics is driven by leading edge circuitry.

Our unparalleled design capability means unparalleled producibility, testability and reliability in the advanced printed circuitry we build.

To the Military/Aerospace/Defense industry we serve, that means unparalleled performance.

For circuit performance beyond expectations, call us. We'll help you begin.

*Sheldahl...First In Design, First In Performance.*

**Sheldahl**

Cirtel Circuit Division
2302 Barranca Road
Irvine, CA 92714
714/660-1510

Nashua Circuit Division
100 Northeastern Blvd.
Nashua, NH 03061
603/883-5541

**1-800-328-3448 Ext. 246**

Certified to the latest revision of:
MIL-P-55110, MIL-P-50884, MIL-P-45743

Cirpack Design
16692 Hale Ave.
Irvine, CA 92714
714/660-0541

Northfield Circuit Division
North Highway 3
Northfield, MN 55057
507/663-8000

**CIRCLE NO 151**

# Circuit provides 16-bit R/D conversion

Leonard Schupak
*Northrop Corp, Anaheim, CA*

**Fig 1** shows a novel way of providing excitation to a resolver (an electromechanical shaft-position transducer) and digitizing the resulting rotor signal with 16-bit resolution. The circuit drives the resolver's two stator windings with sine and cosine waveforms and then converts the rotor output using a PLL ($IC_4$) and a 16-bit divider (cascaded counters $IC_5$ and $IC_6$). The conversion rate is 60 samples/sec.

Because the resolver's stator signals are in quadrature, they create a rotating magnetic field within the resolver housing. In turn, this field induces a constant-amplitude sinusoidal signal in the rotor winding. The phase of this signal (with respect to the sine component of stator excitation) is a measure of the rotor's position. Comparator $IC_{2A}$ detects this phase by switching at the signal's zero crossings.

Alternate crossings produce a positive transition at $IC_{3A}$'s Q output. Note that the counter/register chips $IC_5$ and $IC_6$ contain 8-bit counters as well as latched registers with 3-state outputs. When the Load inputs (pins 13) see a positive transition, they cause the registers to load a 16-bit word representing the rotor position at that instant. The system updates this internal data 60 times/sec, and the host computer gains access to the data by activating the Output Enable signals (pins 14).

Op amps $IC_{1A}$, $IC_{1B}$, and $IC_{1C}$ form a compact quadrature oscillator that operates at approximately 60 Hz. (You set $V_{REF}$ so transistor $Q_1$ conducts near the peak of the cosine signal, which resets the integrators and renews their integration cycle. The result is a low-distortion, constant-amplitude sine and cosine output.) Comparator $IC_{2B}$ detects the sine output's zero crossings for use by the PLL as a reference-phase signal.

Components $R_1$ and $C_1$ set the frequency of the PLL's voltage-controlled oscillator (VCO). You select these components to provide a frequency $2^{16}$ times the 60-Hz

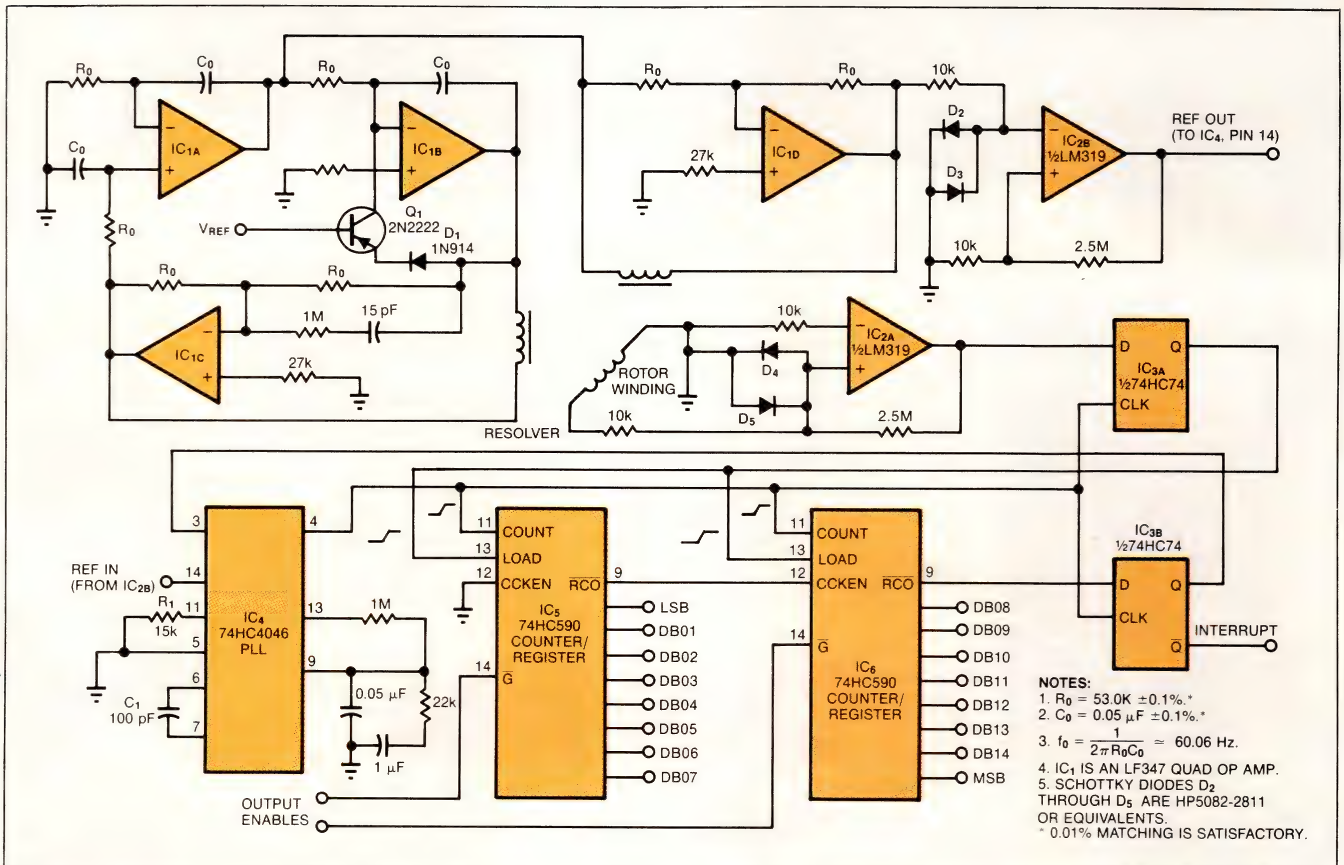



***Fig 1—This inexpensive circuit provides excitation*** *for a 5-kΩ resolver while generating 16-bit samples of the resolver's rotor position at a rate of 60 samples/sec.*

excitation frequency, or approximately 3.93 MHz. (Note that the required values may vary among different 74HC4046 manufacturers.) The 74HC4046's Ref In signal thus synchronizes the PLL to the 60-Hz excitation frequency and, in turn, the VCO output (pin 4) synchronizes operation of the digital ICs. As a consequence, the divider's 65,536 counts fit neatly into the 16.67-msec sampling interval. $IC_6$'s Ripple Carry Output signal (pin 9) denotes the end of a sampling interval; flip-flop $IC_{3B}$ then provides feedback to the PLL and flags the host computer with an Interrupt signal.

The op amps will directly drive 5-kΩ resolver windings as shown; you can add buffer amplifiers to drive lower-impedance windings. The maximum allowed rate of resolver-shaft rotation in this system is about one-tenth of the excitation frequency—6 rps or 3600°/sec. Factors that affect A/D-conversion accuracy include the zero-crossing detector $IC_{2A}$'s jitter, offset, and response time; the excitation-waveform accuracy; and ripple on the VCO control voltage. The system yields a conversion error of +0, −1 count, which is typically smaller than the net error inherent in the resolver. **EDN**

**To Vote For This Design, Circle No 746**

# Controller automatically adjusts fan speed

Trevor Preston
*Astromed Ltd, Cambridge, UK*

The controller circuit of **Fig 1** can reduce a fan's noise, power consumption, and wear, particularly in the presence of a low but fluctuating ambient temperature. You mount a temperature sensor in the fan's airstream, and the circuit adjusts the fan speed as necessary to maintain a relatively constant sensor temperature.

Input components $R_1$ and $C_1$ integrate the input square wave, producing a quasitriangular wave at the noninverting input of op amp $IC_{1A}$. At this inverting input is a reference voltage that decreases as temperature increases. (The 2-terminal sensor produces 1 μA/°K.) The result is a rectangular wave at the output of $IC_{1A}$ with a duty cycle proportional to absolute temperature. Thus, a rise in temperature triggers a counteracting cooling effect by delivering more power to the fan.

To calibrate the system with the sensor at room temperature, simply adjust $R_2$ for a 50% duty cycle at $V_1$. The fan will switch off at approximately 0°C and will be fully on at 44°C. **EDN**

**To Vote For This Design, Circle No 747**

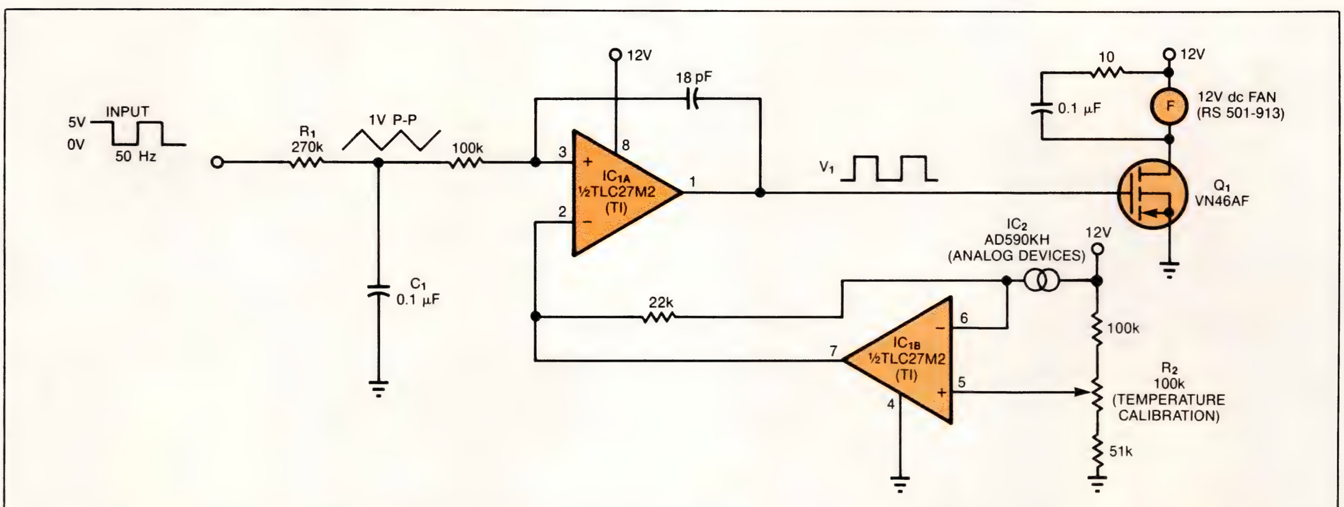



*Fig 1—**This fan-controller circuit** automatically adjusts the fan speed to maintain a relatively constant temperature in the vicinity of the temperature sensor.*

SEEQ EEPROMS IN SPACE.

# Save Time On Service Calls To Locations Like This.

Designing electronic products that work well in remote locations can be tricky. Regardless of whether they're 17,000 miles straight up, or just a stone's throw away, field service calls are expensive.

One way to bring these costs down to earth is to design in SEEQ EEPROMs. Whenever you need to reconfigure a product or change its programming in the field, SEEQ $E^2$s let you do it with a simple phone call or radio message. No parts to exchange. No special gear to haul around. And no equipment downtime while your customers wait for the service person to arrive.

SEEQ $E^2$s also let you cut the power requirements for your next product launch. Our 64K and 256K CMOS $E^2$s run on less than ¾ watt per Megabyte — about one-tenth the power of competitive parts. In standby, they actually go to 150 $\mu$A — about 400 times less than NMOS parts. So they don't need bulky power supplies and heavy cooling equipment that may be hard to get off the ground.

SEEQ $E^2$s give you the kind of performance you need for those applications that are on the horizon too. In page mode, they let you write a byte in 160 $\mu$sec. For a 64K part, that means the entire memory can be updated in just 1.3 seconds — four times faster than the industry average.

Add to that the high endurance and inherent reliability of SEEQ $E^2$s — including operation over extended and full military temperature ranges — and you'll know why SEEQ has become a leading supplier of non-volatile memory products.

At SEEQ, we can help you with virtually any non-volatile memory application — from high-density $E^2$s to microcomputers with $E^2$ on board. For information on remote uses of $E^2$s, call us today for our Application Note #9.

SEEQ Technology, Inc., 1849 Fortune Drive, San Jose, CA 95131. (408) 432-9550.

seeq

MAKES IT MEMORABLE.

CIRCLE NO 149

## Design Entry Blank

**$75 Cash Award for all entries selected by editors. An additional $100 Cash Award for the winning design of each issue, determined by vote of readers. Additional $1500 Cash Award for annual Grand Prize Design, selected among biweekly winners by vote of editors.**

To: Design Ideas Editor, EDN Magazine
Cahners Publishing Co
275 Washington St, Newton, MA 02158

I hereby submit my Design Ideas entry.

Name ______________________

Title ______________ Phone __________

Company ______________________

Division (if any) ______________________

Street ______________________

City __________ State ______ Zip ________

Design Title ______________________

Home Address ______________________

______________________

______________________

Social Security Number ______________
(Must accompany all Design Ideas submitted by US authors)

**Entry blank must accompany all entries.** Design entered must be submitted exclusively to EDN, must be original with author(s), must not have been previously published (limited-distribution house organs excepted), and must have been constructed and tested.

Exclusive publishing rights remain with Cahners Publishing Co unless entry is returned to author or editor gives written permission for publication elsewhere.

In submitting my entry, I agree to abide by the rules of the Design Ideas Program.

Signed ______________________

Date ______________________

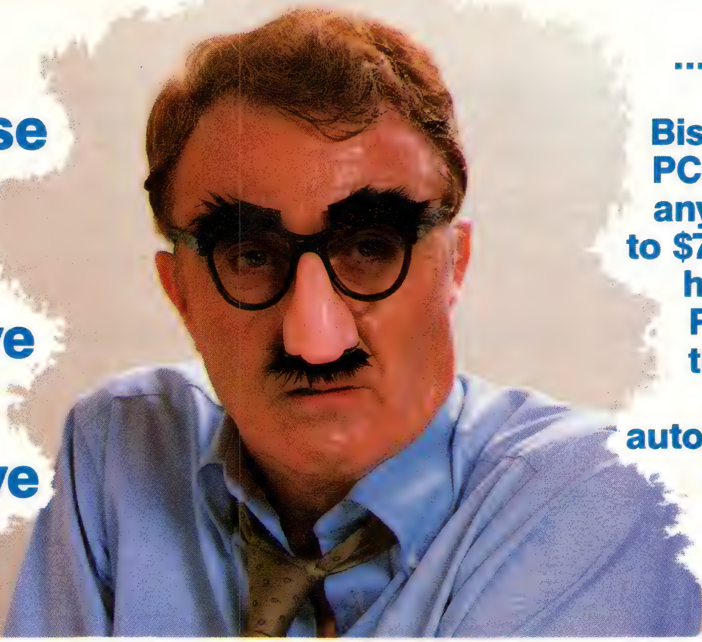
**Your vote determines** this issue's winner. All designs published win $75 cash. All issue winners receive an additional $100 and become eligible for the annual $1500 Grand Prize. **Vote now,** by circling the appropriate number on the reader inquiry card.

**ISSUE WINNER**

The winning Design Idea for the May 28, 1987, issue is entitled "Digital AGC is fast, stable, and accurate," submitted by Kerry Lacanette of National Semiconductor Corp (Santa Clara, CA).

# He Just Spent $175,000 NEEDLESSLY On A Competitive PCB CAD Software System

## You Can't Make Those Kinds of Mistakes and Survive in Today's Competitive World...



## ...especially when he could have owned Bishop's PATHFINDER™ PCB CAD system from anywhere from $1,995 to $7,990. And he would have had, on an IBM PC-based computer, the same schematic capture, layout and autorouting capabilities as the "mainframe-based" software system he bought.

If you've been designing printed circuit boards or doing hand tape-ups during the last 22 years, then you know Bishop Graphics as the world leader in printed circuit design and engineering products. An interesting thing happens when you are effectively the only company selling PCB design products in over 72 countries in the world. You see, there is absolutely no company anywhere in the world that has the existing customer base that Bishop has. As a result, just about every CAD company or author has approached Bishop to either privately label *their* CAD package or distribute it for them.

Now why is that important to you, the engineer, designer or drafter? Simple! We've waited a long time to decide *which* CAD package we wanted to put our name on. We've looked at the advantages and disadvantages of the packages that have been brought to us and we've looked very hard at where the industry is going. The more we looked and compared, the more we realized that PATHFINDER was *the* way to go.

### WHAT MAKES PATHFINDER DIFFERENT?

We know that the majority of the serious designers would like a fully integrated CAD system with an autorouter that can lay down as many as three traces between a DIP if they want. The problem is not a heck of a lot of people can afford to spend $80,000 to $200,000 for a CAD package. **It didn't take us long to realize that PATHFINDER's AutoRouter had the power and performance of the most expense mainframe-based PCB CAD systems.** Nothing that we had evaluated, or that was brought to us (including most of the brand names that you know), could compare with the overall ability of PATHFINDER.

We've sold PCB design products to you for over 20 years and there's one thing that we know for certain...you're not interested in sales hype or fluff. **The problem that we're faced with, is how to convince you that it is foolish to spend $1,000 on a "make do" CAD system and just as foolish to spend $15,000, $20,000, or even $80,000 on a medium to high-end CAD system when you can get the performance of a $90,000 plus CAD system** ***at PATHFINDER's prices.***

### LET'S TALK FACTS AND SPECIFICATIONS

PATHFINDER works in conjunction with, and uses the industry standard for 2D drafting... AutoCAD.™ You get a complete PCB and electro-mechanical 2D CAE workstation. You have full schematic drawing and capture, layout plus 32-bit autorouting. Not only can you create your own netlists, partslists, etc. but you can take an ASCII formatted list or document from another CAD system and format it so that PATHFINDER will read it. You've also got full IGES and Gerber I/O capability. PATHFINDER even allows you to "preview" your photoplot *before* sending it out to be plotted. You have generation of silkscreen and solder mask layers, drill drawings, assembly drawings, fabrication drawings, fast "on-the-fly" parts creation, 3D views, color or monochrome at any resolution, hardware pan and zoom, the use of a TTL, discrete and connector part library, stretching the layout, the latest concept of "what you see is what you get" (WYSIWYG), ratsnesting, drag and rubber-banding, semi-automatic heat sinks, keepout areas, top and bottom views for SMT with 3D views, and on and on.

### MAINFRAME PERFORMANCE AUTOROUTING

The power and speed of a true 32-bit autorouter is what PATHFINDER's AutoRouter is all about. We supply you, along with the AutoRouting software, a parallel processor card that allows you to autoroute using 32-bit integer manipulations. We don't play any games when we talk about true 45° routing. You get it with PATHFINDER. None of this 90° routing and then go back and chamfer the corners to make it look like a 45° route was actually done. We know, and you know, that buys you absolutely no additional "real estate" on the board.

PATHFINDER also provides you with *real time Display While Routing.* What good does it do to come back *after* the autorouting has taken place only to discover that you wish you would have stopped it 5 minutes into the routing design to make a manual edit? Also, you'll be able to autoroute down to 6¼ mil trace widths...3 traces between a DIP pad.

Another thing we discovered is that even mediocre autorouters can achieve 100% completion rates if the parameters are sloppy enough. The real test of autorouting is not just speed, not just percent completion, but most importantly the *quality of design.* **You'll achieve the same kind of performance and completion rates that you would achieve on mainframe-based autorouters with PATHFINDER.** You can autoroute up to 16 layers. You have total access to the strategy parameters given you in the AutoRouter including rip-up and re-route when needed.

### FREE TECHNICAL HOT-LINE SUPPORT

Whether you're doing analog, digital or SMT work, PATHFINDER allows you the ability to get the job done. It's easy to use and comes with a thorough, complete technical manual and tutorial. It is a fully integrated, intuitive CAD system expressed in terms that the PCB engineer, designer or drafter can appreciate. Bishop will provide free technical hot-line support during your first year of use.

### NO-RISK GUARANTEE

We are so thoroughly convinced that PATHFINDER will become the de facto standard in the industry that we'll let you use it for 30 days and if it doesn't meet our published specifications, we'll refund your money with no questions asked. We suggest that you take a minute now to call our toll-free number, 800-222-5808,* to get any of your questions answered that haven't, and can't, be answered in an ad. If you'd like to drop us a line, certainly do so, and mark your envelope "PATHFINDER."

**In Alaska, California, and Hawaii call (818) 991-2600.*

### AVAILABLE NOW!

**PATHFINDER**
**Schematic Capture & Layout**
**$1,995.00 (order #40000)**

**PATHFINDER**
**"Standard" AutoRouter**
**$2,995.00 (order #40020)**

The Innovators
**Bishop Graphics**
**CAD Systems Corporation**
5388 Sterling Center Drive
Westlake Village, CA 91359
Phone (818) 991-2600
Telex 66-2400 (BISHOP WKVG)
Facsimile (FAX) 1(818) 889-3744

**CIRCLE NO 148**

## Recruitment Opportunities with... Westech ExpoCorp

**...COMMITMENT**
**...INNOVATION**
**...EXCELLENCE**

These were more than words to us when Westech began in 1981. It was our philosophy then, and today is an integral part of our business life. In fact, going in to our sixth year of producing successful career events and recruitment publications throughout America, another word can be added to the list...EXPERIENCE.

...EXPERIENCE in producing Career Expos that have realized cost effective recruiting results from coast to coast, with special emphasis in high technology communities of the WESTERN UNITED STATES...

...EXPERIENCE in publishing recruitment magazines that are specifically designed to reach experienced technical candidates in the Southern and Northern California markets.

...EXPERIENCE in delivering COMMITMENTS, INNOVATION and EXCELLENCE to our clients that constantly achieve cost effective recruitment results with our products.

## Westech Career Expo™

Westech Career Expos are designed to put you face to face with experienced, currently employed and hard to reach Engineering, Computer, Data Processing and Software professionals. In 1987 Westech will produce over 25 events in 8 major West Coast and Sun-Belt markets.

Over the past six years, companies have been able to hire an average of 5 exempt level professionals per Career Expo attended. Surveys indicate, the cost effectiveness of our "open house format" is surpassed only by employer referral programs and 98 percent of all exhibiting companies return to recruit at future Westech events.

Once you've involved your company in a Westech event, you're sure to make us an on-going and integral part of your recruitment campaign.

**For additional information on Westech Career Expos held in Santa Clara, CA; Los Angeles, CA; Long Beach, CA; San Diego, CA; Seattle, WA; Denver, CO; Phoenix, AZ; Dallas, TX; Austin, TX and other special locations, please call us today at (408) 970-8800.**

## High Technology CAREERS™ Magazine

High Technology Careers, the Nation's largest independently produced recruitment publication, blankets the Santa Clara Valley and neighboring counties with a circulation of over 330,000 copies.

HTC's distribution, utilizing the San Jose Mercury News, provides advertisers with the largest readership among high-technology professionals residing in Santa Clara and surrounding areas.

The extensive distribution coupled with favorable advertising rates makes High Technology Careers Northern California's most significant recruitment advertising media purchase.

**High Technology Careers Magazine is published every other month, six times a year. Call today for closing dates and rate information. (408) 970-8800.**

## Professional CAREERS™ Magazine

Southern California supports the nation's largest engineering and computer workforce, Professional Careers magazine delivers circulation of 120,000 to these technical professionals.

Our compilation of home addresses in Southern California consists of more than seventy publications, associations and user groups serving the engineering, programming and data processing communities.

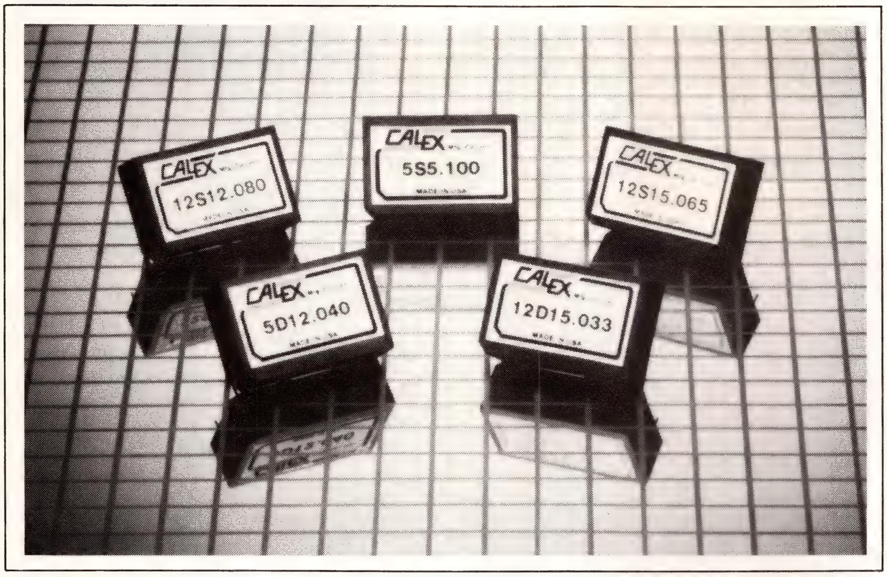
Professional Careers is read by a select group of experienced professionals chosen solely by the trade journals that they read and the organizations that they belong to. The concentrated distribution of Professional Careers makes it Southern California's most targeted and cost-effective recruitment advertising media purchase.

**Professional Careers Magazine is published every other month, five times a year. Call today for closing dates and rate information. (408) 970-8800.**


We pushed our Series IV beyond MIL spec so you can push it to new limits.

# NEW PRODUCTS

## COMPONENTS & POWER SUPPLIES




### DC/DC CONVERTERS

- *LC filters protect input from current noise*
- *Accommodate 5 or 12V inputs*

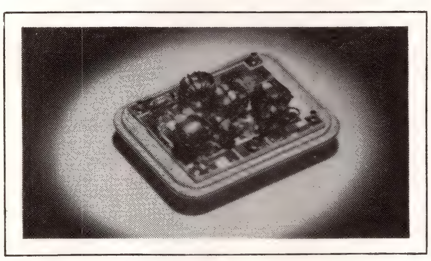
This family of miniature dc/dc converters (1.25×0.8×0.4 in.) includes five units that accept 5V inputs and five models that work with 12V inputs. Both types provide outputs of 5, 12, 15, ±12 and ±15V. Output power varies from 0.5 to 1W. LC filters protect the inputs from current noise, and the output noise is 20 mV p-p. The converters have a 50% efficiency rating and tolerate a ±10% variation in input voltage. All units have continuous output short-circuit protection and 300V dc of input-to-output isolation. The converters are vacuum encapsulated, require no external components for operation, and carry a 5-year warranty. From $50. Delivery, stock to six weeks ARO.

**Calex Manufacturing Co Inc,** 3355 Vincent Rd, Pleasant Hill, CA 94523. Phone (415) 932-3911. TLX 269888.

**Circle No** 351

### MODULATOR

- *Designed for MIL-STD-883 environmental conditions*
- *50-MHz modulation bandwidth*



The Model MOP-103 quadrature modulator consists of two biphase modulators, a 90° quadrature hybrid, and an in-phase power divider. It accepts a 70-MHz RF carrier and two data inputs at ±20 mA. Specs include a 50-MHz modulation bandwidth, 0.2-dB RF-output amplitude balance, 1.5° of output phase tolerance, and 5-dB max insertion loss. The maximum RF-input level is 4 dBm, and the output harmonic suppression is 40 dB min. The unit is designed for MIL-STD-883 environmental conditions and is housed in a package that measures 1.5×1×0.5 in. $138.

**KDI Electronics Inc,** 60 S Jefferson Rd, Whippany, NJ 07981. Phone (201) 887-8100.

**Circle No** 352

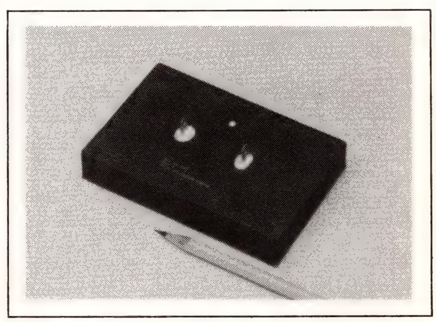
### OPTICAL ENCODER

- *Detects linear position*
- *No signal adjustments required after mounting*

When operated in conjunction with an appropriate code strip, the HEDS-9200 module detects linear position. The module consists of a lensed LED source and a detector IC enclosed in a small C-shaped plastic package. Because of its highly collimated light source and special detector array, the encoder tolerates mounting misalignment—no signal adjustment is required after mounting. You access the two quadrature outputs and the 5V supply input through four pins located on 0.1-in. centers. Three standard resolutions are available: 4.72, 5, and 5.91 counts/mm. $23.75 (250).

**Hewlett-Packard Co,** 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

**Circle No** 353



### HIGH-WATTAGE RESISTOR

- *For snubber applications*
- *Housed in a nonmetallic package*

The SPR-2182 is designed for load or snubber applications. It employs processing techniques that combine high-wattage capabilities with low corona. The resistor is housed in a nonmetallic package designed for mounting on a temperature-controlled heat sink. When so mounted, it will dissipate as much as 650W.

Resistance values range from 0.01Ω to 35 kΩ. The unit measures 4.5×3×0.8 in. and is available with a standard tolerance of 2, 3, 5, or 10%. Typical unit, $26.95 (100). Delivery, eight weeks ARO.

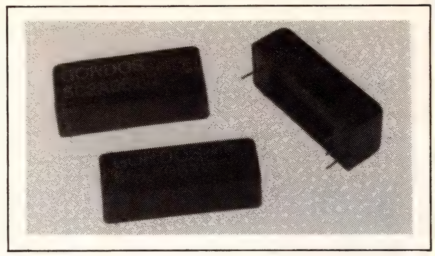
**Dale Electronics Inc,** 2064 12th Ave, Columbus, NE 68601. Phone (402) 564-3131.

**Circle No** 354

## REED RELAYS

- *$10^8$-operation lifetime*
- *Magnetic or electrostatic shielding available*

Valuline Series reed relays are available in open or encapsulated versions. All materials used in their construction conform to UL 94-V0. The relays are available in 1A, 2A,

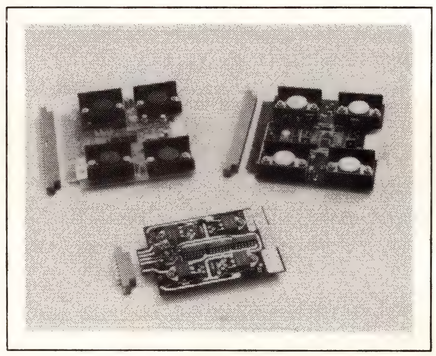


1B, 1C, or 2C contact configurations, with 5, 12, or 24V coil-drive ratings. Standard contact ratings are 200V dc, 0.5A switching, and 2A carry. The expected lifetime is $10^8$ operations min. Optional features include either magnetic or electrostatic shielding, and an insulating resistance of $10^{13}$Ω at 200V dc. The line includes units that will switch 1000V dc and models that have mercury-wet contacts for handling 2500V dc/1A, in accordance with FCC Part 68 requirements. Form 1A, $0.70 (OEM qty). Delivery, four to six weeks ARO.

**Gordos Corp,** 1000 N Second St, Rogers, AR 72756. Phone (800) 643-3500.

**Circle No** 355

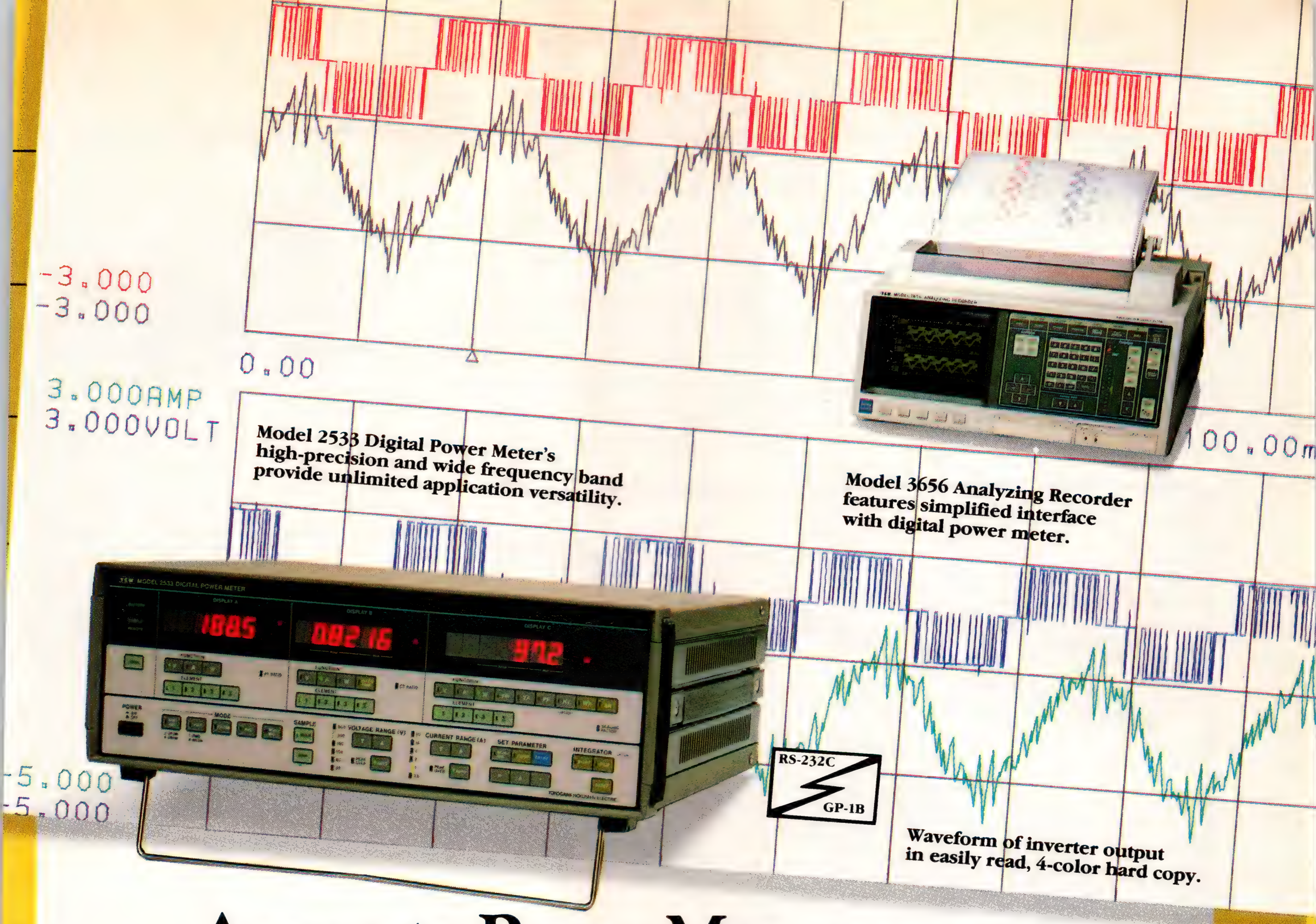




## MOTOR DRIVERS

- *Drive any 5-, 6-, or 8-lead stepper motor*
- *Accept CMOS-compatible inputs*

These board-type cards can drive any 5-, 6-, or 8-lead stepper motor. They accept CMOS-compatible input pulses and convert each pulse to one motor step in the proper sequence. Series resistors keep phase currents within the driver specification. You can program the input to accept either pulse and rotation or CW/CCW rotation inputs.



-3.000
-3.000
0.00
3.000AMP
3.000VOLT
Model 2533 Digital Power Meter's high-precision and wide frequency band provide unlimited application versatility.
Model 3656 Analyzing Recorder features simplified interface with digital power meter.
100.00m
-5.000
-5.000
RS-232C
GP-1B
Waveform of inverter output in easily read, 4-color hard copy.

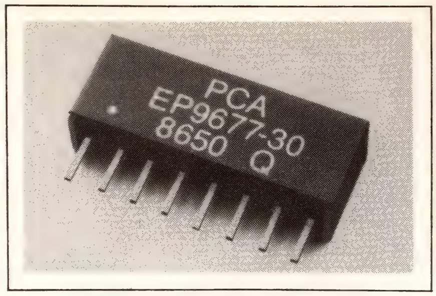
Some models also feature a full- or half-step drive option. The three available models have ratings of 5A per phase. The supply-voltage ratings range from 5 to 50V dc. $100 to $250.

**General Controls Inc,** 2011 Devon Ave, Elk Grove Village, IL 60007. Phone (312) 595-2152.

**Circle No 356**

## DELAY LINES

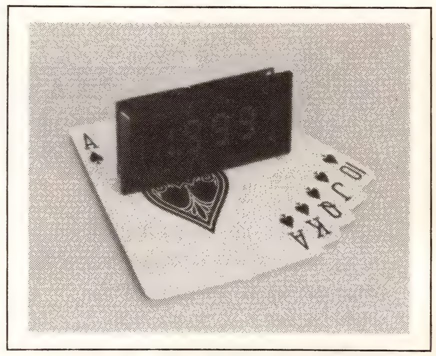
- *Minimize real-estate needs*
- *500-nsec max delay time*




The EP9677 Series 5-tap, TTL-compatible delay lines are housed in a 0.82×0.19-in. SIP (single in-line package) that reduces pc-board space requirements. The series includes 25 members; their maximum delays range from 4 to 500 nsec (±5% or ±2 nsec, whichever is greater). The delay-line input and the five equally spaced taps are buffered by a Schottky TTL inverter. The delay lines have a 0 to 70°C operating range and a maximum output rise time of 4 nsec. $2.20 (1000) for a 50-nsec device. Delivery, stock to six weeks ARO.

**PCA Electronics Inc,** 16799 Schoenborn St, Sepulveda, CA 91343. Phone (818) 892-0761.

**Circle No 357**



## DIGITAL PANEL METERS

- *500,000-hour min MTBF*
- *LCD readable in direct sunlight*

DP-650 panel meters have 15-mW power consumption, 500,000-hour min MTBF, and overvoltage protection to 350V dc. Three versions are available with full-scale input ranges of ±199.9 mV dc, ±1.999V dc, and ±19.99V dc, respectively. The liquid-crystal display is readable in direct sunlight as well as under low light conditions. An internal dc/dc converter, an integrating dual-slope ADC, and differential inputs combine to provide 0.1% measurement accuracy. Standard meter features include auto-zero, automatic polarity display, 1-pA input cur-

# the simple solution...

## to your challenging enclosure problems

...a concept so simple, engineers often overlook it and end up wasting untold thousands of dollars for specially designed and built enclosures.

### Problem-solving versatility is its most unique advantage

Complex structures for specialized and non-standard application become easy to design with AMCO's rugged aluminum structural system of in-stock aluminum extrusions and corner castings. This one-of-a-kind method features strong 1 1/2″ (O.D.) 6061-T6 aluminum extrusions in fourteen mounting flange combinations, seven 356-T6 cast corners, a hinged corner plus optional locking or non-locking corner assembly clips—to provide virtually unlimited enclosure configurations for military and commercial projects. Extruded tubing with integral flanging accommodates flat or flush mounted panels as well as equipment mounting.

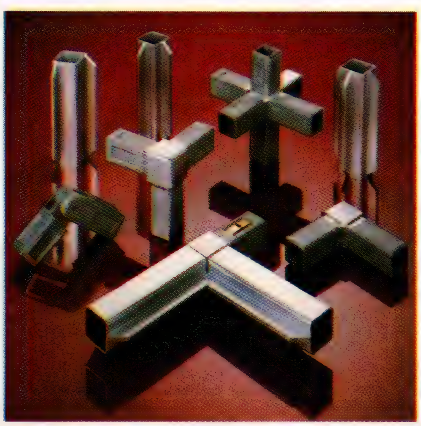
### Stronger than welding—it does the job others can't do economically

Not a single AMCO aluminum structure has failed to meet requirements demanded by military and commercial users— in over 20 years. The secret to this remarkable success is gusseting. Combined with the naturally high strength-to-weight ratio of the aluminum itself, bolt-on 3/16″ 5052-H34 aluminum gussets can provide the added strength you may need. In fact, these durable, long-lasting enclosures will survive shock and vibration testing under MIL-Spec E-5272C, MIL-STD-167-1 and MIL-STD-810C. In most cases, tight tolerance control can be maintained to your needs.

### The Process

The extrusions are cut to the desired panel size; length and width. Then mitre the panel mounting flanges, insert clips in casting recesses and assemble with a mallet. Use adjustable corner for angles up to 120 degrees. If you prefer, AMCO will assemble your aluminum frame or provide a complete enclosure assembly—often saving additional costs by using standard AMCO panels, doors, blowers and accessories.

AMCO's aluminum structural system can solve your design and assembly problems as effectively as it has for some of the most difficult military and commercial projects known to modern technology. AMCO aluminum enclosures are in use at Army, Navy, Air Force and NASA installations around the world—including shipboard and under-sea, aerospace, ground and mobile applications; process control and heavy electrical generating installations; special electronic and communications systems and even weather-sealed outdoor structures.



**For your FREE Aluminum Structural System Catalog #203 write or call**

**TOLL FREE 1-800-833-3156**
In Illinois, call (312) 671-6670

**AMCO Engineering Co.**
3801 N. Rose Street
Schiller Park, IL 60176-2190

"Quality is no accident"

AMCO®

FAX: 312-671-9469 TWX: 910-227-3152

rent, and overvoltage indication. A hold-display mode is also standard. $17.25 (1000).

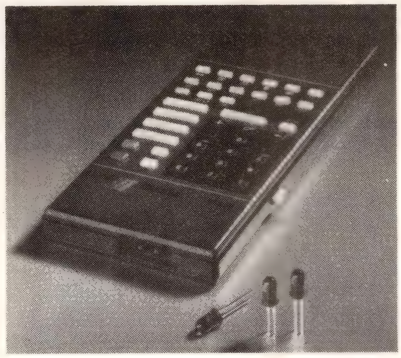
**Acculex Corp,** 440 Myles Standish Blvd, Taunton, MA 02780. Phone (617) 880-3660.

**Circle No** 358

## INFRARED LEDs

- *Works for data-carrier frequencies >1 MHz*
- *Exhibit no output loss after 5000 hours operation*

Featuring a switching speed of 30 nsec (around 15 times faster than conventional devices) the CQW-58A, -89A, and -89B infrared LEDs allow you to increase the data rate between remote equipment and control handsets. In remote control applications you can use a carrier frequency of greater than 1 MHz. All the devices radiate at a wavelength of 830 nm. The LEDs are fabricated



using GaAlAs technology. After 5000 hours of continuous operation, with a drive current of 100 mA, the devices exhibit no drop in their radiant intensity. The drop in radiant intensity after 100,000 hours of operation is projected to be around 15%. You can drive the LEDs with pulsed currents as high as 2.5A. The CQW58A is packaged in a 3-mm diameter SOD-53F capsule with a maximum power rating of 100 mW. The CQW89A and CQW89B are housed in 5 mm diameter SOD-63 capsules with a maximum power rating of 300 mW. The CQW89A has a half-intensity beam width of 40°; the CQW89B has a beam width of 12° for longer distance operation. Approximately gld 0.45 (1000).

**Philips,** Elcoma Division, Box 523, 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.

**Circle No** 359

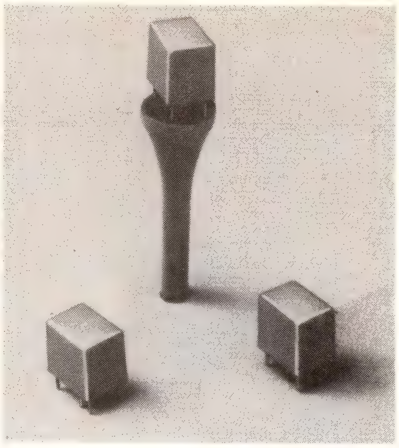
**Amperex Electronic Corp,** 230 Duffy Ave, Hicksville, Long Island, NY 11802. Phone (516) 931-6200.

**Circle No** 360

## MINI RELAY

- *Requires less than 0.12 in² of pc-board space*
- *Conforms to UL 94V-0 flammability rating*

The Type MN electromechanical relay is designed for pc-board mounting. The standard unit mea-



sures 0.406×0.287×0.39 in. The relay is provided in an spdt contact configuration and is rated for 1A. Standard sensitivity is 210 mW. Other contact forms and lower pick-up sensitivities are available. The relay's flammability and surge resistance ratings conform to UL 94V-0 and FCC Part 68 (1500V) requirements, respectively. $1.15 (1000).

**Communications Instruments Inc,** Box 520, Fairview, NC 28730. Phone (704) 628-1711.

**Circle No 361**

## POWER SUPPLIES

- *Operate in constant-voltage or -current modes*
- *Are remotely programmable via analog input signals*

The Series-1000 Mk II range of power supplies includes 26 different models with output-voltage ranges of between 0 to 35V and 0 to 1000V, and current ratings of between 10A and 30 mA. All the models are fully programmable, providing either constant-voltage or constant-current operation with automatic cross-over between operating modes. Line regulation in both modes is ±0.015% for ±10% line-voltage variation. In constant-voltage mode, zero to full-load regulation is 0.015% or 5 mV, whichever is greater, and in constant-current mode, it's 0.05% or 3 mA for a 50% output voltage change. Options are available to provide 0.01% regulation in constant-current mode, and crowbar output protection. Programming inputs allow you to adjust the output voltage via a 0 to 5V input signal, and the current via a 0 to 1V input signal. The power supplies are housed in 19-in. rack- or bench-mounting enclosures. They operate from 200/250V line supplies. From around £1000 to £4000.

**Hunting Hivolt Ltd,** Riverbank Works, Old Shoreham Rd, Shoreham-by-Sea, West Sussex, BN4 5FL, UK. Phone (0273) 454511. TLX 87466.

**Circle No 362**

**Hunting Hivolt,** 1008 W 9th Ave, King of Prussia, PA 19406. Phone (215) 265-7462.

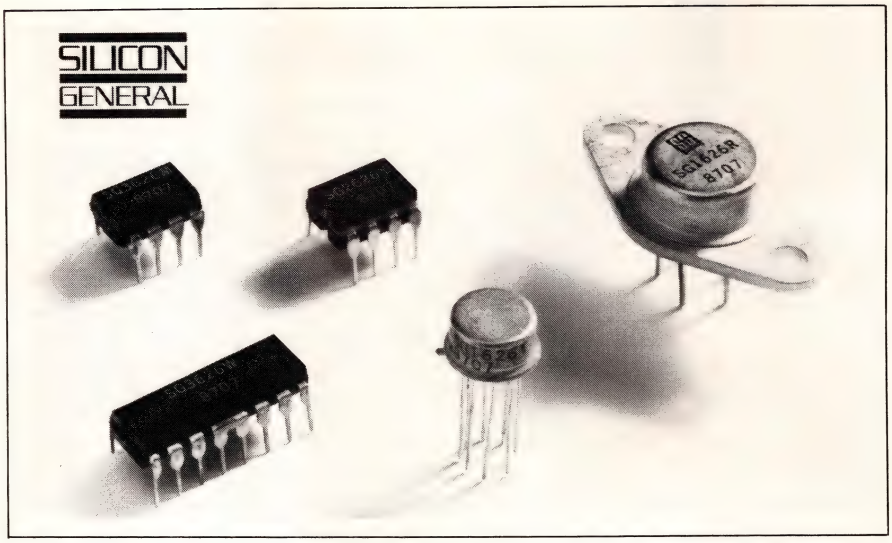
**Circle No 363**

## INTEGRATED CIRCUITS

### MOSFET DRIVERS

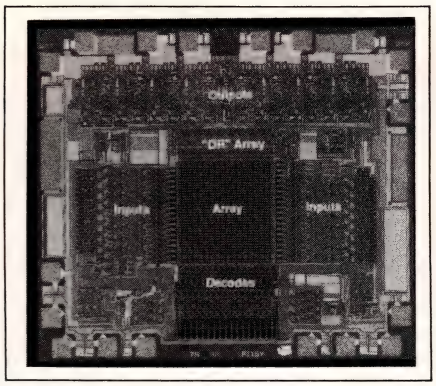
- *Totem-pole outputs (3A peak)*
- *Switch 2500-pF load in 40 nsec*

The SG1626/SG3626 are dual, inverting, monolithic drivers suitable for driving power MOSFETs and for applications that require digital signals to drive large capacitive loads. The devices' 3A-peak current capability can drive 2500-pF loads in less than 40 nsec. The drivers use high-voltage Schottky logic that converts TTL signals to 18V outputs without driving the outputs deeply into saturation. The package options include 8-pin plastic and ceramic DIPs, 16-pin bat-wing, TO-99, and TO-66. An 8-pin plastic DIP, 0-to-70°C version, $0.90 (10,000). Delivery, 12 weeks ARO.




**Silicon General Inc,** 11861 Western Ave, Garden Grove, CA 92641. Phone (714) 898-8121. TWX 910-596-1804.

**Circle No 385**



### FAST PLAs

- *10-nsec propagation delay*
- *Clock frequencies to 70 MHz*

The 16L8D, 16R4D, 16R6D, and 16R8D constitute a family of programmable-logic arrays (PLAs) that are compatible with the company's Fast product line. The PLAs offer 10-nsec propagation delays and clock speeds to 70 MHz. Proprietary on-chip test circuitry enables the manufacturer to eliminate devices that could cause ac failures after programming. Furthermore, the manufacturer guarantees that all devices meet the 10-nsec propagation spec, regardless of the programmed cell pattern. $8 (100). Available in the fourth quarter of this year.

**Fairchild Semiconductor Corp,** 333 Western Ave, South Portland, ME 04106. Phone (800) 554-4443.

**Circle No 386**

### FIFO MEMORIES

- *Achieve typical data rates of 30 MHz*
- *Are cascadable to increase word width or FIFO buffer depth*

The 74HC7030 and 74HCT7030 are 64×9-bit CMOS FIFO memories with CMOS- and TTL-compatible inputs and outputs, respectively. Independent shift-in and shift-out controls allow you to use them as synchronous or asynchronous data buffers with typical data transfer rates as high as 30 MHz. Input- and output-ready signals indicate the full or empty status of the FIFO memory, and 3-state outputs are provided that let you cascade devices and produce FIFO memories with greater word width or depth. The devices are available in 28-pin DIP or small-outline surface mount packages. Corresponding input and output pins are positioned opposite each other on the package to ease pc board layout. Around $40 in small quantities.

**Philips,** Elcoma Div, Box 523, 5600 AM Eindhoven, The Netherlands. Phone (040) 757005. TLX 51573.

**Circle No 387**

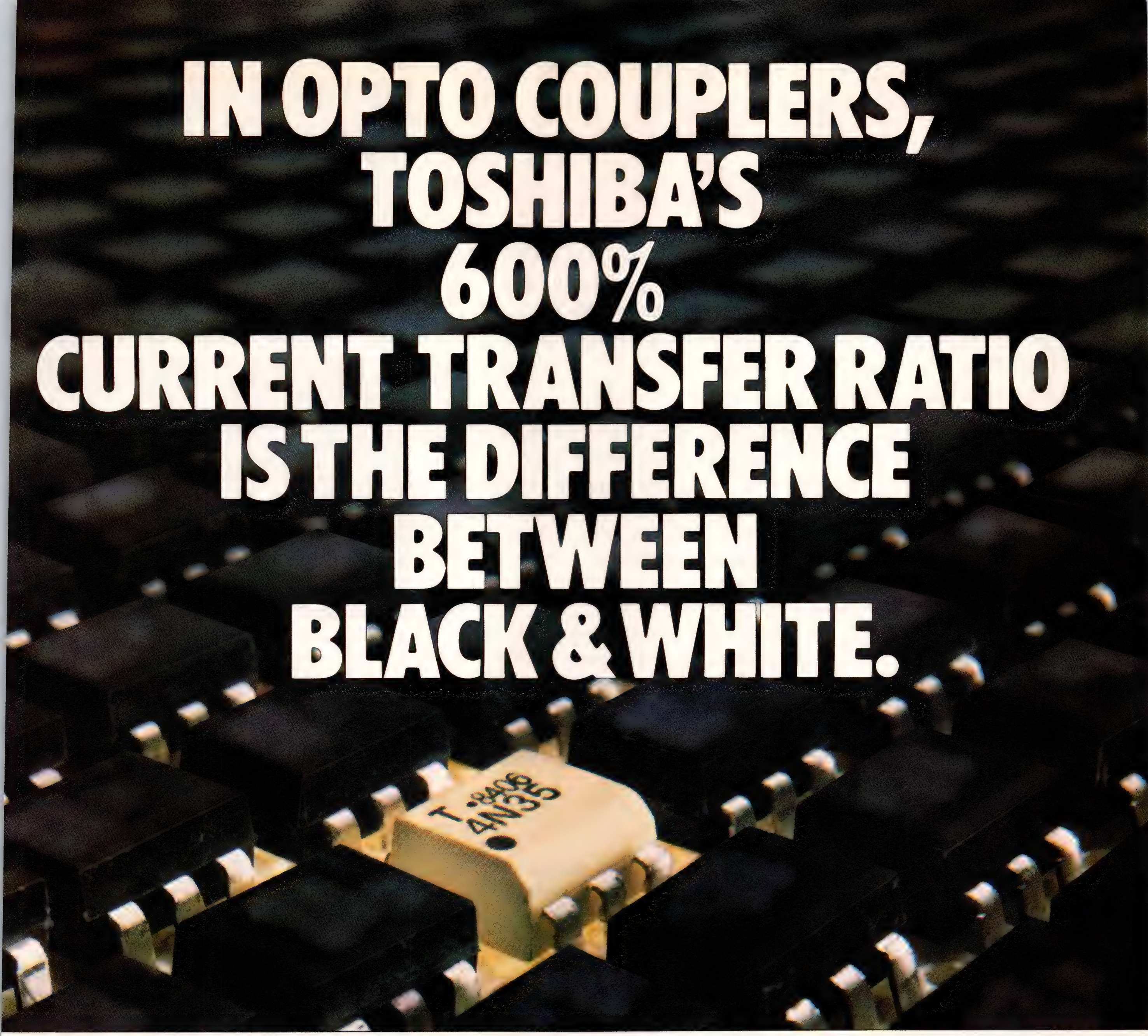
**Signetics Corp,** 811 E Arques Ave, Sunnyvale, CA 94088. Phone (408) 991-4571.

**Circle No 388**

### GATE ARRAYS

- *550-psec propagation delays*
- *0.25-mW/gate power dissipation typ*

The four devices in the BC series of BiCMOS gate arrays offer densities from 430 to 2160 3-input gates. Propagation delay is 550-psec and the typical power dissipation is 0.25-mW/gate. The input and output buffers' propagation-delay times are 3.0 and 5.5 nsec, respectively. The BC family offers either 10-mA or




White mold — Toshiba's patented material — makes possible the highest current transfer ratio available — minimum 200% and in some devices up to 600% for transistor output.

This kind of technological superiority is one reason why Toshiba is the world's largest maker of opto couplers.

But whether you want high CTR, isolation voltage up to 5000V AC — or speed up to 10 MHz — with UL and VDE/BSI approvals, you want Toshiba.

Call or write today for Toshiba's Opto Coupler product summary.



**SOME TYPICAL PHOTOCOUPLER APPLICATIONS**
(Call for Information on Additional Products)

| OUTPUT | APPLICATION | | | | | |
|---|---|---|---|---|---|---|
| | PROGRAMMABLE CONTROLLER | INVERTER | SSR | POWER SUPPLY | OFFICE AUTOMATION | TELE-COMMUNICATION |
| TRANSISTOR | TLP620-4<br>TLP621-4<br>TLP624-4<br>TLP626-4 | TLP636 | TLP731<br>TLP732 | TLP731<br>TLP732 | TLP731<br>TLP732 | TLP620-2<br>TLP621-2<br>TLP624-2<br>TLP626-2 |
| DARLINGTON TRANSISTOR | TLP523-4<br>TLP627-4 | | | | | TLP627-2<br>TLP677<br>TLP678 |
| HIGH SPEED PHOTO-IC | TLP2200<br>TLP2601<br>TLP2631 | TLP550<br>TLP2200<br>TLP260 | TLP550<br>TLP2200 | TLP550<br>TLP2200 | TLP2200<br>TLP2531<br>TLP2631 | TLP2200<br>TLP2531<br>TLP2631 |
| SCR | TLP645G<br>TLP645J | TLP645G<br>TLP645J | TLP741G<br>TLP741J | TLP741G<br>TLP741J | TLP741G<br>TLP741J | TLP645G<br>TLP645J |
| TRIAC | TLP525G-4<br>TLP3022<br>TLP3043<br>TLP3063 | TLP3022<br>TLP3043<br>TLP3063 | TLP3022<br>TLP3043<br>TLP3063 | TLP3022<br>TLP3043<br>TLP3063 | TLP3022<br>TLP3043<br>TLP3063 | TLP525G-2<br>TLP3022<br>TLP3043<br>TLP3063 |

**TOSHIBA OPTO COUPLERS.**
**THE DIFFERENCE BETWEEN BLACK AND WHITE.**

**TOSHIBA AMERICA, INC.**

**TOSHIBA AMERICA, INC., SEMICONDUCTOR PRODUCTS DIVISION,** 2692 DOW AVENUE, TUSTIN, CALIFORNIA 92680. **REGIONAL SALES OFFICES: WESTERN REGION,** TOSHIBA AMERICA, INC., 2692 DOW AVENUE, TUSTIN, CA 92680 (714) 832-6300; **CENTRAL REGION,** TOSHIBA AMERICA, INC., 1101A LAKE COOK ROAD, DEERFIELD, IL 60015 (312) 945-1500; **EASTERN REGION,** TOSHIBA AMERICA, INC., 67 SOUTH BEDFORD STREET, SUITE 200W, BURLINGTON, MA 01803 (617) 272-4352; **SOUTHEASTERN REGION,** TOSHIBA AMERICA, INC., 5555 TRIANGLE PARKWAY, SUITE 300, NORCROSS, GA 30092 (404) 368-0203.

**AUTHORIZED REPRESENTATIVES: CALIFORNIA,** BAGER ELECTRONICS, (714) 957-3367, (818) 712-0011, (619) 944-4188, ELREPCO INC., (415) 962-0660; **DELAWARE,** NEXUS TECHNOLOGY SALES, (215) 675-9600; **ILLINOIS (NORTHERN),** CARLSON ELECTRONIC SALES, (312) 956-8240; **IOWA,** CARLSON ELECTRONIC SALES, (319) 377-6341; **NEVADA,** ELREPCO INC., (415) 962-0660; **NEW JERSEY,** NEXUS TECHNOLOGY SALES, (201) 947-0151; **NEW YORK (LONG ISLAND, WESTCHESTER COUNTY),** NEXUS TECHNOLOGY SALES, (201) 947-0151; **PENNSYLVANIA (EASTERN),** NEXUS TECHOLOGY SALES, (215) 675-9600; **WISCONSIN,** CARLSON ELECTRONIC SALES, (414) 476-2790.

**CIRCLE NO 142**

# VF Technology... The Bright Decision

Futaba, a world leading manufacturer of vacuum fluorescent displays, offers a wide assortment of *display tubes* in many sizes and formats. Also, Futaba offers *display modules* with all the electronics required to refresh the display and easily interface with the host system.

## GRAPHIC DISPLAY

Both front glass phosphor, which provides maximum viewing angle and uniform surface appearance, and conventional back glass phosphor, with optimum brightness and software dimming capabilities, are available. All Futaba graphics modules offer complete drive electronics, bit mapped control with a DC/DC converter. All active components are surface mounted onto a single board.

## DOT MATRIX MODULES

Utilizing Futaba's dot matrix displays, a completely intelligent line of "dot modules" is available. Each includes all drive, power supply and microprocessor components surface mounted onto a single board. Surface mounted technology results in higher reliability and allows for a smaller overall package and lower cost. All dot modules require only a 5V DC power source and can accept parallel or 8 possible serial baud rates.

## GRAPHIC DISPLAYS/MODULES

| Futaba Display | Futaba Module | Pixels (Row X Char.) | Brightness (FT-L) | Module Dimensions (in.) |
|---|---|---|---|---|
| GP1005B | GP1005B03 | 128X64 | 400 | 7.28X3.35X1.77 |
| GP1006B | GP1006B04 | 256X64 | 200 | 9.84X3.35X1.77 |
| GP1009B | GP1009B03 | 240X64 | 200 | 6.2X2.76X1.57 |
| GP1010B | GP1010B01 | 176X16 | 200 | 7.32X2.16X1.70 |
| GP1002C | GP1002C02 | 320X240 | 100* | 7.10X6.30X1.60 |
| GP1004B | GP1004B03 | 640X400 | 30 | 9.65X7.28X1.85 |

*Different Versions Available

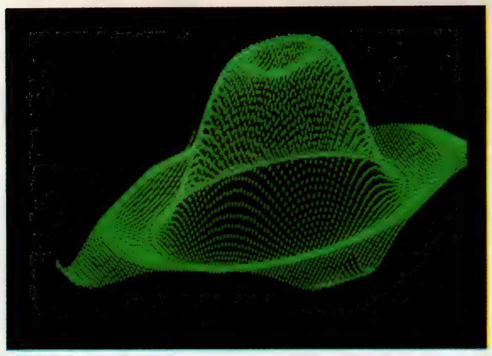
## DOT MATRIX DISPLAYS/MODULES

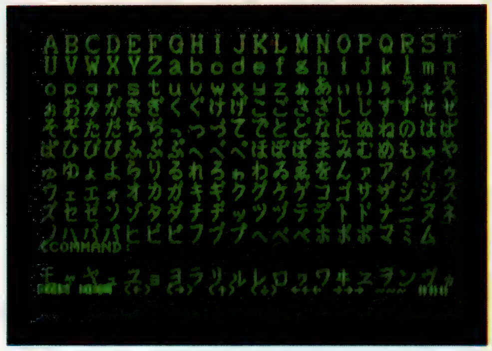
| Futaba Display | Futaba Module | Char. X Row | Dot Format | Char. Ht. (in.) | Module Dimensions (in.) |
|---|---|---|---|---|---|
| 20SD01Z | M20SD01 | 20X1 | 5X7 | 0.200 | 6.3X1.97X.75 |
| 20SD42Z | M20SD42 | 20X1 | 5X12 | 0.344 | 7.1X2.16X.88 |
| 40SD02Z | M40SD02 | 40X1 | 5X7 | 0.200 | 9.45X2.16X.88 |
| 40SD42Z | M40SD42 | 40X1 | 5X12 | 0.344 | 9.45X2.16X.88 |
| 202SD03Z | M202SD03 | 20X2 | 5X7 | 0.200 | 6.7X2.56X.90 |
| 402SD04Z | M402SD04 | 40X2 | 5X7 | 0.200 | 10.43X2.56X.90 |
| MANY OTHER DISPLAYS | NEW MODULES AVAILABLE SOON | | | | |

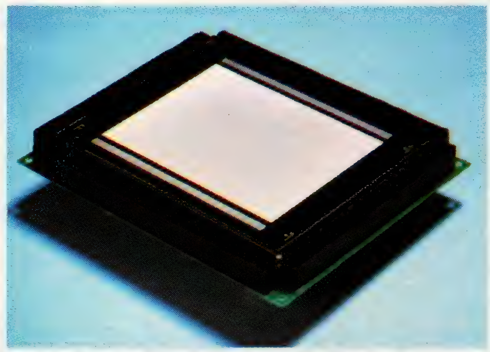

**FUTABA**
**Corporation of America**
Electronic Components Division

711 E. State Parkway
Schaumburg, IL 60173

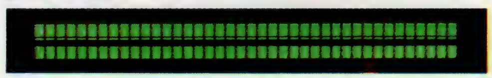
Telephone: (312) 884-1612
or (312) 884-1444

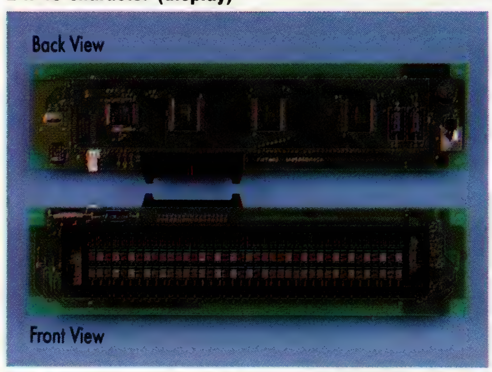




Compact, flat panel graphic displays and modules present clean, sharp images, whether for text or full graphics application.



2 x 40 character (display)




2 x 40 character (module)

Pattern flexibility and pleasing appearance are offered by Futaba in dot displays and modules.

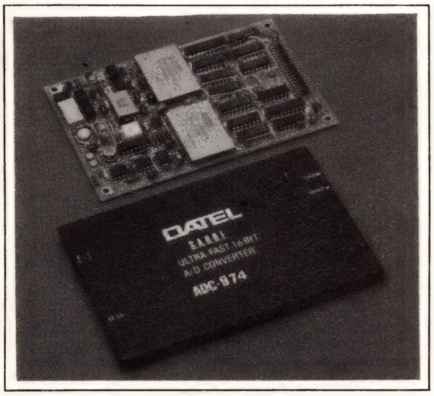
Futaba also offers a complete catalog of alphanumeric, segmented displays.

Futaba supports its products with design engineering and system integration assistance. Call or write today.

24-mA TTL-compatible output drive; the output buffer's power dissipation is 4 mW at 10 mA and 8 mW at 24 mA. BC400 in a 44-pin PLCC, from $7.85 (1000). Delivery, eight weeks ARO for initial silicon samples; 14 weeks ARO for production quantities.

**Fujitsu Microelectronics Inc,** 3320 Scott Blvd, Santa Clara, CA 95054. Phone (408) 727-1700. TWX 910-338-0190.

**Circle No 389**




## A/D CONVERTER

- *16-bit resolution; 2.5-μsec conversion time*
- *14-bit accuracy*

Using a 2-pass conversion architecture, the ADC-974 A/D converter accomplishes a 16-bit conversion in 2.5 μsec. The integral-linearity error is guaranteed to ±½LSB max for resolutions as high as 14 bits. The converter accepts inputs over the ±5V range and produces 2's complement output code. The output is configured as two octal 3-state latches. The offset drift is ±1 LSB (at 14 bits) over 0 to 70°C. The reference-voltage temperature coefficient is ±5 ppm/°C. Supply voltages are ±5 and ±15V; the maximum power dissipation is 8.4W. It's packaged in a 6×4×0.375-in. black enameled-steel module. $999. Delivery, stock to eight weeks.

**GE/Datel,** 11 Cabot Blvd, Mansfield, MA 02048. Phone (617) 339-9341. TWX 710-346-1953. TLX 951340.

**Circle No 390**

## MOTOR DRIVER

- *Provides a full H-bridge output*
- *Delivers peak currents as high as 5A*

Housed in an 18-pin plastic DIP, the L6202 motor driver IC can deliver 70W of power. It has a full H-bridge output and interfaces directly to TTL-level control logic. Operating at a switching frequency of 100 kHz and a junction temperature of 120°C, the driver can deliver continuous rms currents as high as 1.5A at motor supply voltages as high as 54V. The peak nonrepetitive output current limit is 5A. Within this limit, the available output current is limited only by power dissipation. Six pins on the 18-pin DIP are dedi-

## INTEGRATED CIRCUITS

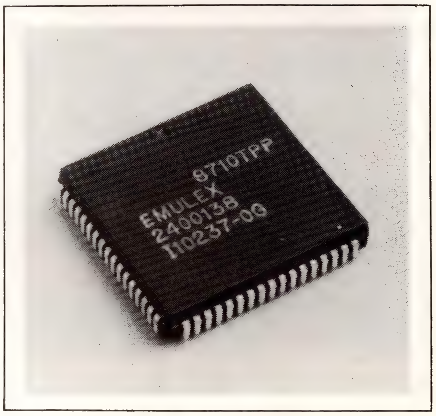
cated to heatsinking the die to the pc board. A similar device, the L6203, can deliver as much as 4A rms to provide 250W of motor power. The L6202, $5 (100).

**SGS Microelettronica SpA,** Via C Olivetti 2, 20041 Agrate Brianza, Italy. Phone (039) 65551. TLX 330131.

**Circle No 391**

**SGS Semiconductor Corp,** 1000 E Bell Rd, Phoenix, AZ 85022. Phone (602) 867-6100. TLX 249976.

**Circle No 392**




## SCSI PROCESSOR

- *Implements SCSI-bus protocol*
- *Replaces less integrated components*

The ESP chip is a VLSI device that implements the communications protocol of the SCSI bus. As a host adapter embedded on a CPU motherboard or as a controller embedded with drive electronics, the chip replaces existing discrete devices, external drivers, and any earlier SCSI-interface chip. It features a dual-ranked command and transfer counter; bus sequences implemented without μP intervention; a 16-byte FIFO memory; single-ended, 48-mA bus transceivers; and a sustained transfer rate of 3M bytes/sec (asynchronous) or 4.8M bytes/sec (synchronous). It comes in a 68-pin PLCC. $25 (1000).

**Emulex Corp,** Box 6725, Costa Mesa, CA 92626. Phone (800) 368-5393; in CA, (714) 662-5600.

**Circle No 393**

# The ARX20 Automatic Router never goes home, never takes a break, never gets sick, never makes a mistake, and never leaves any routing incomplete

The ARX20™ automatic router from Scientific Calculations is a high performance processor driving powerful multiple algorithms for total routing of large, complex, high density printed circuit boards. The off-line server can queue and route any number of designs from any number of workstations through a Local Area Network (LAN). It performs unattended, day and night, freeing your users and CAD systems for other work. Unlike other systems, it handles clearances, trace widths and vias of *any size.* And it won't compromise your design rules. It "sees through" up to 32 board layers at once, determining instantly where there are congested areas and where the best trace paths are. You can query the system anytime to determine route status. Automatic cleanup routines reduce the number of vias, shorten trace lengths and eliminate loops and hooks. The ARX20 system CPU is the full 32-bit MC68020 microprocessor hosting the UNIX V operating system. Physical memory ranges to 12MB. The unit is 29″ high, 19″ wide and 31″ deep. For more information, write or give us a call. We'll give you a demonstration.

7635 Main Street, Fishers, NY 14453
1-800-4-HARRIS Ext. **4302**
1-800-344-2444 (Canada)

HARRIS
SCIENTIFIC CALCULATIONS

ARX20 is a trademark of Scientific Calculations.
MC68020 is a trademark of Motorola.
UNIX V is a trademark of AT&T Bell Laboratories.



**CIRCLE NO 147**

## TELEPHONE IC

- *Includes speech and dialer functions*
- *Automatically compensates for the length of the subscriber line*

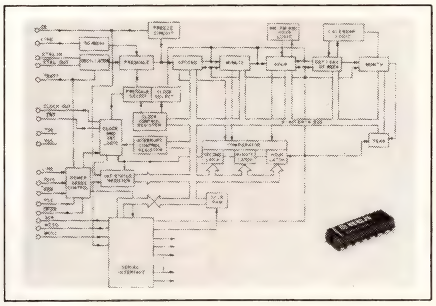
The MA534 CMOS loop disconnect dialer IC features an integrated speech circuit that complies fully with BS-6305 and -6317 requirements for class A complex matched telephones. The IC also features a 21-digit last-number-redial memory, selectable make/break ratio of 2:1 or 3:2, and a selectable interdigit pause of 800 or 400 msec. The dialer can perform earth-loop and timed-break recall, and no dial output is generated if more than one dial-pad key is pressed simultaneously. All timing is derived from an external, low-cost, 560-kHz ceramic resonator. To compensate for the lower attenuation characteristics of short lines, the device automatically adjusts the gain of its speech circuits so that the volume of received speech is independent of line length. The speech circuits are suitable for dynamic or electret transducers. The MA534 is housed in a 16-pin DIP, and you can power it directly from the telephone line. £3 (100).

**Marconi Electronic Devices Ltd,** Doddington Rd, Lincoln LN6 3LF, UK. Phone (0522) 688121. TLX 56380.

**Circle No 394**

**Marconi Electronic Devices Inc,** 45 Davids Dr, Hauppauge, NY 11788. Phone (516) 231-7710. TLX 275801.

**Circle No 395**



## CLOCK IC

- *Clock and calendar functions*
- *2.2V operation*

The CDP68HC68T1 is a CMOS real-time clock for µP systems. The monolithic chip indicates seconds, minutes, hours, day of the week, and date. It also lets µC systems implement timer, power up/down, and power sensing functions. The IC communicates with the µC over the SPI (Serial Peripheral Interface) bus of the 68C05 or 68HC11, or the four I/O-port lines of µCs such as the 1804A, 80C51, and the 65C02. The chip also includes a power-monitor function and a 50-Hz, 60-Hz, or crystal-clock reference. The chip's 32 bytes of internal static RAM provide parameter storage, computer handshaking, and an interrupt

# IS SCOPE SETUP A SOURCE OF DELAY?

**The Tek 2465A with AUTO SETUP is the time-saving solution.** See up to four waveforms on-screen at the touch of a button. Your display is triggered and scaled automatically, without having to adjust a single knob. Add other standard features such as 350 MHz probe-tip bandwidth, 2 mV/div sensitivity and auto trigger level—all in a scope **made** for solving tough problems in analog design. It makes troubleshooting trouble-free!


# CUT IT OUT!

---

☐ Please send me your free videotape introduction, "The 2445A/2465A Family: From Performance to Productivity."

☐ Please send me your free 22-page brochure.

☐ Please have a Tek representative get in touch with me as soon as possible to arrange a demonstration.

**Yes! I want a closer look at the Tek 2445A/2465A Family.**

Name

Title

Company

Address

City State Zip

( )

Phone Ext

D887-6-38AX EDN

**Tektronix**®
COMMITTED TO EXCELLENCE

# SCOPES CUT OUT FOR YOUR KIND OF WORK.

**Accurate measurements, accurately interpreted.** The 350 MHz 2465A builds on proven, industry-standard high performance. You can easily measure pulse parameters and frequency with on-screen cursors. Full bandwidth is maintained at 2 mV/div sensitivity to monitor low-amplitude signals such as noise and ripple with full fidelity.

You can make timing measurements with 20-ps resolution at sweep speeds to 500 ps/div. And trigger on 500 MHz signals from any one of four channels or on four asynchronous channels. Dual, delaying time bases mean precise measurements on complex waveform details.

**Measurement options, extended capabilities.** For specialized performance requirements, five combinable enhancements are available —a GPIB interface, digital multimeter, counter/timer functions with enhanced triggering, 17-bit word recognition and video measurement capabilities.

Three multiple-option packages, the 2465A Special Editions, are configured for specific application areas at a significant savings over the separately ordered options.

All models come with Tek's comprehensive three-year warranty on labor and parts, including the CRT.

**Get the full story!** Return the reply card to Tek today. For a hands-on demonstration, call your Tek Sales Engineer.

| Key Features | 2465A DV | 2465A DM | 2465A CT | 2465A | 2445A |
|---|---|---|---|---|---|
| Probe Tip Bandwidth | 350 MHz | 350 MHz | 350 MHz | 350 MHz | 150 MHz |
| No. of Channels | 4 | 4 | 4 | 4 | 4 |
| Horizontal Accuracy | 2% (.001%*) | 2% (.001%*) | 2% (.001%*) | 2% (.001%*) | 2% (.001%*) |
| Max. Sweep Speed | 500 psec | 500 psec | 500 psec | 500 psec | 1 nsec |
| Vertical Sensitivity | 2 mV/div | 2 mV/div | 2 mV/div | 2 mV/div | 2 mV/div |
| Trigger Frequency | 500 MHz | 500 MHz | 500 MHz | 500 MHz | 250 MHz |
| GPIB | Standard | Standard | Standard | Optional | Optional |
| Counter/Timer/ Trigger/Word Recognizer | Standard | Standard | Standard | Optional | Optional |
| Digital Multimeter | Standard | Standard | Not Available | Optional | Optional |
| Video Trigger | Standard | Not Available | Not Available | Optional | Optional |
| Probes | 4 | 4 | 4 | 2 | 2 |
| Warranty | 3 years on parts and labor, including CRT | | | | |

*with Counter/Timer/Trigger

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

**BUSINESS REPLY MAIL**
FIRST CLASS PERMIT NO. 1 BEAVERTON, OR

POSTAGE WILL BE PAID BY ADDRESSEE

**Tektronix, Inc.**
P.O. Box 1700
Beaverton, OR 97077

structure. Any one of three internal sources can provide an interrupt: the alarm circuit (seconds, minutes, hours); one of 15 periodic signals (subsecond to daily events); or power failure. The timer functions include a 12- or 24-hour format with an AM/PM indicator. The calendar counters provide day of the week and day/month/year with automatic leap year. The device operates on 3 to 6V; at 2.2V, it can maintain time-keeping functions while drawing 10 μA of supply current. The package options are a 16-lead plastic or ceramic DIP or a 20-lead SO (small-outline) package. Plastic-DIP version, $3.16 (100).

**GE/RCA Solid State,** Box 2900, Somerville, NJ 08876. Phone (201) 685-6771.

**INQUIRE DIRECT**

## RAD-HARD ICS

- *Feature radiation hardness to military requirements*
- *Include decoders, octal buffers, latches, and flip-flops*

The 54HSC- and 54HST-Series CMOS SOS (silicon-on-saphire) ICs are CMOS- and TTL-compatible devices, respectively, which are pin compatible to industry standard 54/74-LS and -HCT devices. However, both series are available with radiation-hardness specifications that meet both military (MIL-STD-883S) and space (ESA-9000) requirements. The ionizing dose is rated at $10^5$ to $10^6$ rad(Si) for military usage, and $10^6$ to $10^7$ rad(Si) for space usage. The transient upset dose rate is $>10^{10}$ rad(Si)/sec, and neutron density (1 MeV) capability is $>10^{15}$ neutrons/cm$^2$. The series currently includes decoders/demultiplexers, octal buffer/line drivers, transceivers, transparent latches, and edge-triggered flip-flops. They are available in DIPs or leadless chip carrier packages. A typical octal device is priced at around £80 (100).

**Marconi Electronic Devices**

**Ltd,** Doddington Rd, Lincoln LN6 3LF, UK. Phone (0522) 688121. TLX 56380.

**Circle No 396**

**Marconi Electronic Devices Inc,** 45 Davids Drive, Hauppauge, NY 11788. Phone (516) 231-7710. TLX 275801.

**Circle No 397**

## FM RECEIVER

- *Dual-conversion circuitry*
- *6- to 35-mW power consumption*

A narrowband-FM, dual-conversion, low-voltage (2V) receiver, the MC3362 IC incorporates all essential VHF-receiver functions from the antenna input to the audio preamp output. The chip handles RF inputs as high as 180 MHz, or over 400 MHz if you provide the first local-oscillator signal externally. It consumes between 6 and 35 mW and features dual-conversion circuitry, a received-signal-strength output, and a data-slicing comparator that allows recovery of FSK data at rates as high as 30k bps. The operating-temperature range is −40 to +85°C. $1.80 (100).

**Motorola Inc,** Box 52073, Phoenix, AZ 85072. Phone (602) 897-3842.

**Circle No 398**

## FIFO MEMORIES

- *64×4-bit and 64×5-bit organizations*
- *15-nsec access time*

The SSL7401-SSL7404 family of four BiCMOS FIFO memories is suitable for use in high-speed communications and controller applications, as buffers between digital systems with widely differing bit rates, and as A/D-converter buffers. All parts offer a 50-MHz throughput rate, a 15-nsec data-access time, a 2-nsec data setup time, and a 1-nsec data-hold time. Each device is expandable in width and depth and conforms to industry-standard pin configurations: SSL7401, 64×4-bit in a 16-pin DIP; SSL7402, 64×5-bit in an 18-pin DIP; SSL7403, 64×4-bit with output enable in a 16-pin DIP; and SSL7404, 64×5-bit with output enable in an 18-pin DIP. 50-MHz SSL7401, $68.18 (100).

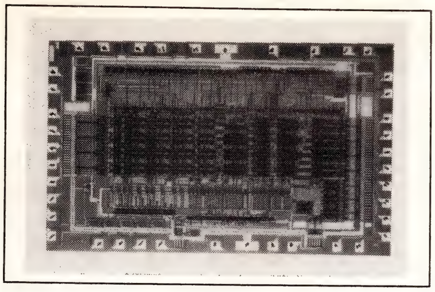
**Saratoga Semiconductor,** 10500 Ridgeview Ct, Cupertino, CA 95014. Phone (408) 864-0500.

**Circle No 399**

## INTERFACE ADAPTER

- *Compatible with all 68000 μPs*
- *Offers bidirectional parallel and serial ports*

The monolithic CMOS R65NC22 provides 68000-based systems with two 16-bit counters, one serial bidirectional port, and two 8-bit bidirec-



tional parallel I/O ports. Other features include 5V operation, TTL-compatible control lines, an expanded handshake capability that allows positive control of data transfers between the processor and peripheral devices, and latched input and output registers on both I/O ports. Commercial and industrial temperature versions are available in a 40-pin plastic or ceramic DIP or a 44-pin PLCC. Including a 5-year warranty, $5.20 (1000).

**Rockwell International Corp,** Box C, Newport Beach, CA 92658. Phone (714) 833-4700.

**Circle No 400**

## ANALOG FILTERS

- *Provide 64- or 256-point FIR filtering*
- *Cascadable for increased filter length*

Based on CCD technology, the WM2120 and WM2130 analog FIR filters can perform 64- and 256-point correlations, respectively. The filters have respective dynamic ranges of 80 and 60 dB, and both feature unity gain between the input and output so that you can cascade devices to obtain longer filter lengths. You can clock the input to sample at frequencies as high as 200 kHz. Time division multiplexed reference coefficients are stored for use in each filter stage on internal sample/hold circuits. A digital shift register controls the multiplexing of the reference coefficients to the appropriate filter stage's sample hold circuit. All clock inputs are compatible with CMOS logic driven from a 15V supply. The WM-2120 and -2130 require +15 and −5V supplies and have typical power consumptions of 120 and 250 mW, respectively. They cost £120 and £250 (10), respectively.

**Wolfson Microelectronics Ltd,** Lutton Court, Bernard Terrace, Edinburgh EH8 9NX, UK. Phone 031-667-9386. TLX 727659.

**Circle No 401**

## FILTER IC

- *Allows you to design nonaliasing switch-mode filters*
- *Filters operate at frequencies as high as 1 MHz*

The WM3015 is an evaluation device to illustrate the company's capability to produce custom filters using both switched-capacitor and continuous-time filter techniques. Using a combination of these techniques, the company's filter CAD software

allows you to design low-, high- or bandpass filters operating at frequencies as high as 1 MHz, which are free from aliasing effects. The WM3015 is a 5th order elliptic (Cauer) lowpass filter with a cutoff frequency that you can electronically tune between 10 and 100 kHz. The filter has a dynamic range of 65 dB and consumes 22 mW from a split supply of between ±2.5 to ±3V. The WM3015 costs £55.

**Wolfson Microelectronics Ltd,** Lutton Court, 20 Bernard Terrace, Edinburgh EH8 9NX, UK. Phone 031-667 9386. TLX 727659.

**Circle No 402**

## SIGNAL CONVERTER

- *Converts 80286 signals to those of the 8088*
- *Allows 80286 to run at 10 MHz*

The CMOS EL286-88-10 signal-converter chip, residing on an 80286-based accelerator board, allows you to increase the system speed of IBM PCs, PC/XTs, and compatibles as much as 10 times. The chip also includes a clock generator and a 16-bit bus controller. It converts the 80286 μP's data width, control signals, and circuit timing to those compatible with the 8088 μP. Consequently, the chip appears to the 80286 as 16-bit memory and peripheral devices operating at the 10-MHz 80286 clock rate, and to the 8-bit circuitry on the system's original mother board as an (8-bit) 8088 operating at its own clock rate. The processor clocks can be asynchronous. For example, the 80286 can run at 10 MHz while addressing peripherals operating at the 8088's 4.77-MHz rate. No software changes are involved, and the signal translation is undetectable except for the increase in speed. It comes in a 68-pin PLCC. $25 (1000).

**Edsun Laboratories Inc,** 9 Spring St, Waltham, MA 02154. Phone (617) 647-9300. TLX 853664.

**Circle No 403**

# IRC SURFACE-MOUNT RESISTIVE PRODUCTS OPEN-UP A NEW WORLD OF APPLICATIONS.

## *Standard and custom devices — one source for all*

*From one source you can get virtually every type of discrete resistor and resistor network that can be produced in a surface-mount configuration. All fabricated with proven IRC materials and resistor elements — so reliable performance is a sure thing.*

*IRC was one of the first to offer surface-mount power wirewounds, and our RG Glaze® power chips are the smallest available.*

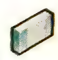
*Our TaNFilm® technology produces resistor networks with exceptional stability, tight tolerances, close TCR tracking, and low noise. These networks, and our chip resistors, also meet or exceed military requirements.*

*If your surface-mount design requires custom-adapted resistors, no problem. And no long wait, either.*

*We're the one source to know, as you move ahead into the world of surface-mount. For product specs or application assistance, contact us: IRC, Inc., Greenway Road, P.O. Box 1860, Boone, NC 28607. Phone 1-800-255-4-IRC. (In NC, 704-264-8861.)*

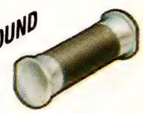
**SURFACE-MOUNT RESISTOR NETWORK**
*50 Ω TO 100K Ω, TOL. TO ± .02%, TCR TRACKING TO 2 ppm/°C*

**SMALL-OUTLINE RESISTOR NETWORK**
*50 Ω TO 100K Ω, TOL. TO ± .02%, TC TO ± 25 ppm/°C*

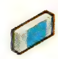


**PRECISION FLAT CHIP**
*50 Ω TO 50K Ω, TOL. TO ± 0.1%, TC TO ± 25 ppm/°C*

**POWER-CHIP RESISTOR**
*1 Ω TO 10M Ω, TOL. TO ± .5%, 1/4 TO 2 W*



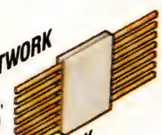
**SEMI-PRECISION WIREWOUND**
*.1 Ω TO 1.5K Ω, TOL. TO ± 0.25%, 3 W*



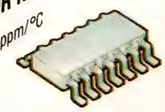
**GENERAL PURPOSE CHIPS**
*10 Ω TO 2.2M Ω, TOL. ± 1% TO 5% 1/8 AND 1/10 W*

**LPW SURFACE-MOUNT RESISTOR**
*.01 Ω TO .5 Ω, TOL. ± 1, 2, & 5% 2 W*

**TaNTee SUBMINIATURE DUAL NETWORK**
*10 Ω TO 10K Ω, TOL. TO ± .1%, 1/4 W*



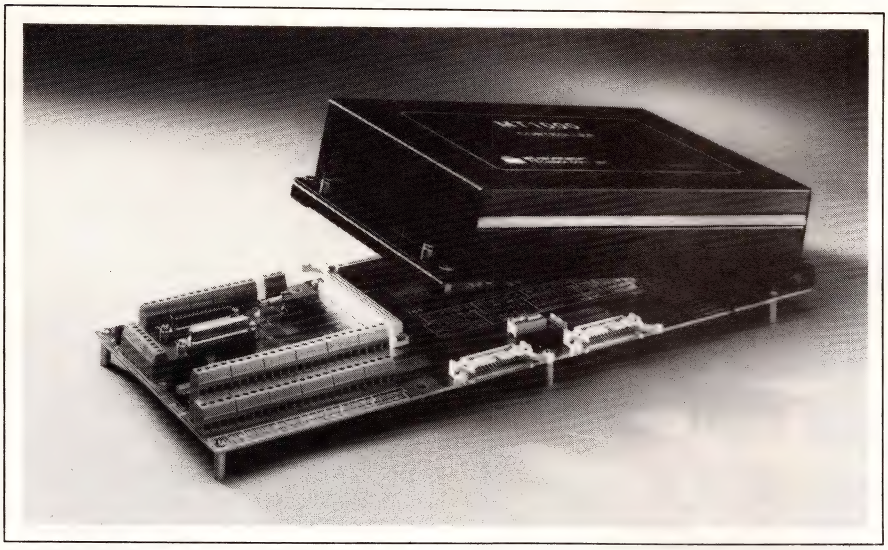
**FLAT PACK RESISTOR NETWORK**
*50 Ω TO 100K Ω, TOL. TO ± .02%, MIL-R-83401 CHARACTERISTIC H*



**DIP GULL-WING RESISTOR NETWORK**
*TOL. TO ± 0.1% STD, TC TO ± 25 ppm/°C (Available 4th quarter 1987)*

**The Resistor People** IRC

*A member of the Crystalate Group*



### OEM CONTROLLER

- *Stand-alone controller for industrial automation*
- *Features Turbo Pascal with software interrupts*

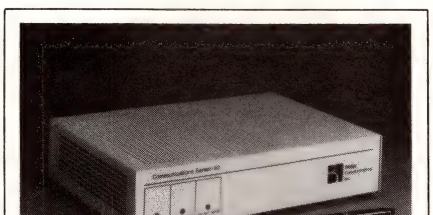
The MT1000 is a measurement and control system for industrial-automation applications. It contains 16 differential and 32 single-ended analog input channels that are multiplexed to a 14-bit A/D converter. It offers four independent analog output channels with 12-bit analog accuracy. The controller also provides 32 digital input or output lines configured on an 8-bit/channel basis. Its communication capabilities include three serial ports configured for RS-232C interfaces. One of the ports can be configured as an optically isolated RS-422 or RS-485 port. At the heart of the controller is a Hitachi HD64180 μP and 64k bytes of onboard RAM (256k bytes are available as an option). A 1024-byte EEPROM is used to store initialization parameters and calibration constants. The board also accepts two 27512 (64k-byte×8-bit) EPROMS that are configured as a 128k-byte ROM. The board is programmed in Turbo Pascal, which includes Software Interrupts that allow you to respond to external events in real time. $1625.

**Measurement Technology Inc,** 1595 Central St, Stoughton, MA 02072. Phone (617) 344-6230.

**Circle No 364**

### LAN SERVER

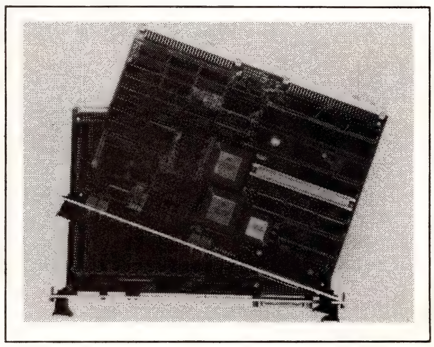
- *Two-port server has small footprint and weighs 7 lbs*
- *Runs the TCP/IP DDN protocol set*



The CS/50 is a small-footprint, 2-port communications server measuring 9×12 in. and weighing 7 lbs. It is available in three versions: a standard Ethernet (IEEE-802.3) LAN interface, a 5M-bps frequency-agile broadband network interface, or a Thin Ethernet (IEEE-802.3) interface. The Thin Ethernet version uses a standard BNC connector to connect to RG58 cable. The server acts as a network data-switching server for terminals, hosts, PCs, printers, and modems. Each asynchronous port has full RS-232C control-line support. The server runs the TCP/IP (Transmission Control Protocol/Internet Protocol) Department of Defense (DoD) protocol set for the Defense Data Network (DDN). Its VLSI circuitry includes an 8-MHz 68000 CPU, 512k bytes of RAM, and an 82586 network controller. Standard Ethernet or broadband version, $1495; Thin Ethernet version, $1595.

**Bridge Communications Inc,** 2081 Stierlin Rd, Mountain View, CA 94043. Phone (415) 969-4400. TLX 176544.

**Circle No 365**



### CPU BOARD

- *Unix engine is based on a 16.7-MHz 68020 CPU*
- *Has paged MMU, coprocessor, and no-wait-state operation*

The CPU-24/25 for the VME Bus is a single-board computer that features a 68020 μP, a 68881 coprocessor, and a 68851 PMMU (paged-memory-management unit) running at 16.7 MHz. The board can access as much as 4M bytes of static RAM without wait states. It accesses the static RAMs, which can be located on VME Bus companion boards, via the Force local memory extension (FLME) interface on a 96-pin con-

nector located in the center of each companion board. The CPU can access banks of static RAM in 45 nsec via the FLME. The board is available with AT&T's Unix System V, release 2. When employing the 68851 PMMU, the board is capable of 3300 Whetstones and can manage demand-paged memory in eight page sizes, ranging from 256 bytes to 32k bytes. In a Unix setting, the PMMU maintains process protection when many users are running separate application programs simultaneously. The 128k-byte EPROM works as a Unix boot ROM for the operating system. The board's 68561 multiprotocol communications controllers (MPCCs) provide two or three serial ports. CPU-25 with 512k bytes of static RAM, $5995.

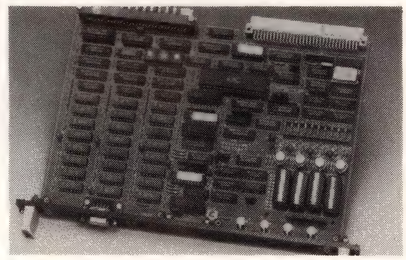
**Force Computers GmbH,** Daimlerstrasse 9, D-8012, Ottobrunn, West Germany. Phone (08960) 0910.

**Circle No 366**

**Force Computers Inc,** 727 University Ave, Los Gatos, CA 95030. Phone (408) 354-3410.

**Circle No 367**





## GRAPHICS BOARD

- *Provides 512×512-pixel, 8-color images*
- *Stores as many as eight images simultaneously*

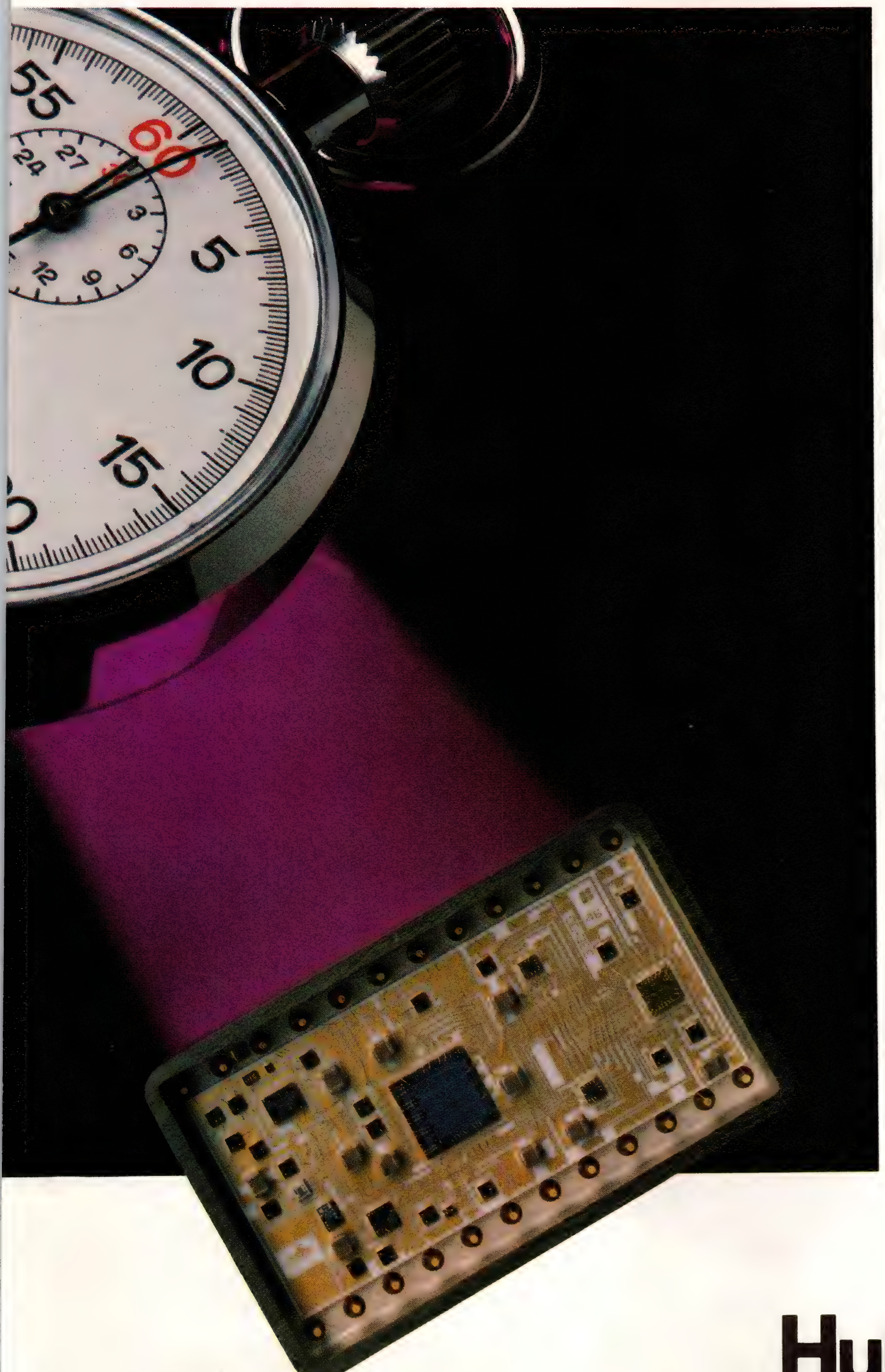
Enhancements to the GRAZ-4 VME Bus CRT-controller/graphics board include the provision of three 256k-byte image memories, which allow you to hold eight 8-color, 512×512-pixel images on the board simultaneously. In addition to its text mode, which provides 16 different font sizes, the board also provides graphics vector drawing speeds as high as 1.5M pixels/sec. Its monochrome mode allows you to drive three CRT displays simultaneously or to translate the eight displayable colors into eight gray-scale levels. The board provides outputs for TTL-level and analog input monitors. The video outputs conform to CCIR video standards at selectable refresh rates of 50 or 60 Hz. The board comes with driver software that supports its text and graphics functions. Approximately $1000.

**Eltec Elektronik GmbH,** Galileo-Galilei-Strasse 11, 6500 Mainz 42, West Germany. Phone (06131) 50630. TLX 04187273.

**Circle No 368**

# Real-Time In No Time.

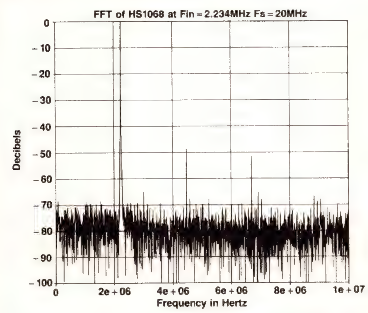
*Our HS 1068 ADC combines a flash converter with all the necessary analog support circuitry into one unit so that you can access real-time capabilities instantly.*



Flash converters broke through the time barrier in A/D conversion. Now, Hybrid Systems shatters the barriers to fast, convenient flash converter integration.

Our HS 1068 takes an industry-standard flash converter; adds a voltage reference, input buffer, and tri-state output; and places them all on one hybrid that's actually smaller than a package containing a flash converter alone. Yet the HS 1068 offers all these features:

- 20MHz minimum sampling rate
- No spurious codes—7MHz, 13MHz typ.
- No missing codes—to 10MHz typ.
- Aperture jitter of 60ps.
- Aperture error of 1LSB at 20MHz input—no sample/hold required for input frequencies lower than 10MHz.
- Signal-to-noise ratio of 46dB—true 8-bits
- Dynamic testing




Most important, you can integrate the HS 1068 into your applications in no time . . . no kidding.

With full MIL-STD-1772 Certification, Hybrid Systems can process the HS 1068 to the most stringent military and commercial specifications, including MIL-STD-883C.

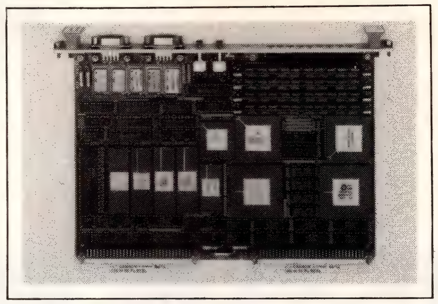
The Hybrid Systems HS 1068: for video digitizing, radar, EW systems, high speed signal processing and all other applications that demand real-time A/D conversion, it's a component whose time has come.

For more information, call or write us today.

**Hybrid Systems**
CORPORATION

22 Linnell Circle, Billerica, MA 01821 617-667-8700

## COMPUTERS & PERIPHERALS



### CPU CARD

- *Sports a 68020 µP, a math coprocessor, and an MMU*
- *Suits distributed real-time multiprocessing systems*

The PG2100 is a 32-bit single-board computer that's suitable for use as a stand-alone computer board or as a CPU card in VME Bus systems. Its 68020 µP, 68881 math coprocessor, and 68851 paged MMU all run at clock frequencies of 16.67 MHz or higher. The MMU provides address translation and access protection for the entire address range of the 68020 µP. The board contains 4M bytes of dual-ported dynamic RAM (which is upgradable to 16M bytes) and space for as much as 256k bytes of EPROM. The board's I/O interfaces include two RS-232C serial I/O ports, an RS-485 serial networking port, and a SCSI-bus interface. The board also has a VMS controller onboard.

**Philips,** Industrial & Electro-acoustic Systems Div, Box 218, 5600 MD Eindhoven, The Netherlands. Phone (040) 788620. TLX 35000.

**Circle No 369**

**Signetics Corp,** 811 E Arques Ave, Sunnyvale, CA 94088. Phone (408) 991-4571.

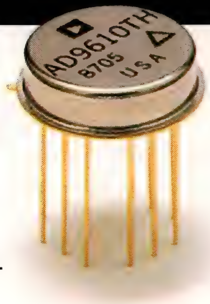
**Circle No 370**

### SCSI HOST ADAPTER

- *Utilizes a full 32-bit data path*
- *Adapter allows communications via the SCSI bus*

The PT-VME420 is a SCSI host adapter for the VME Bus. The adapter, which is based on a 12.5- or 16.7-MHz 68020 CPU, provides a

# YOU WON'T HEAR MUCH NOISE FROM OUR HIGH-SPEED TRANSIMPEDANCE AMPLIFIER.




Forget the noise you hear about other transimpedance amplifiers. It's the noise from the amplifier that's important. And noise voltage for the AD9610 is only 0.7nV$\sqrt{\text{Hz}}$!

Besides low noise, the AD9610 Op Amp features low power consumption – just over 600mW. Cost is 40-50% lower than the competition even in high-rel, mil temp versions.

Moreover, bandwidth is virtually independent of gain. For example, at unity gain, bandwidth is 100MHz. At ± 10, it's 95MHz. And at ± 50, it's still 65MHz.

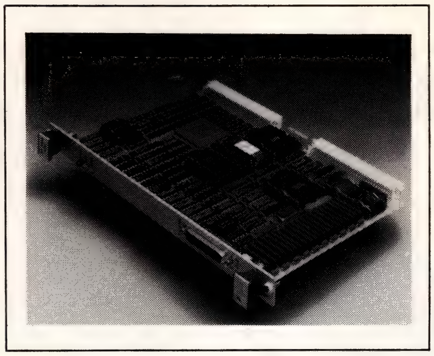
Because the AD9610 has 18ns settling to 0.1%, 3500V/μs slew rates and ample phase margin, it's perfect for pulse applications.

For more information, contact our sales engineers and ask about the AD9610 and its versatile evaluation board. They'll tell you everything you want to hear about this high-performance transimpedance amplifier.

ANALOG DEVICES
The Designer's Advantage

Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106; Headquarters: (617) 329-4700; California: (714) 641-9391, (619) 268-4621, (408) 559-2037; Colorado: (303) 590-9952; Illinois: (312) 980-0300; Maryland: (301) 992-1994; Ohio: (614) 764-8795; Pennsylvania: (215) 643-7790; Texas: (214) 231-5094, (713) 664-6704; Washington: (206) 251-9550; Austria: (222) 885504; Belgium: (3) 237 1672; Denmark: (2) 845800; France: (1) 4687-34-11; Holland: (1620) 81500; Israel: (052) 28995; Italy: (2) 6883831, (2) 6883832, (2) 6883833; Japan: (3) 263-6826; Sweden: (8) 282740; Switzerland: (22) 31 57 60; United Kingdom: (932) 232222; West Germany: (89) 570050

CIRCLE NO 181



full 32-bit data path and address to the VME Bus. It can be operated in the asynchronous (1.5M bytes/sec) or the synchronous (4M bytes/sec) transfer modes on the SCSI bus. It includes 2 DMA devices: one that moves data to and from the SCSI bus at sustained rates of 4M bytes/sec with bursts of more than 5M bytes, and one that moves data over the VME Bus at sustained rates of more than 14M bytes/sec. The DMA engines work concurrently with a 512k-byte dual-ported RAM. All low-level SCSI protocols are handled by the module's firmware. When the adapter operates in the target mode, two host adapters can provide system communications via the SCSI bus. The module includes a firmware-supported RS-232C port that allows for a dynamic-trace display of each step in SCSI-bus transactions. $1650 (100).

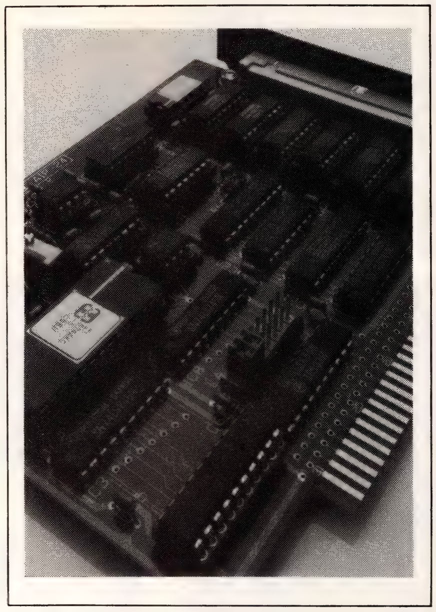
**Performance Technologies Inc,** 435 W Commercial St, East Rochester, NY 14445. Phone (716) 586-6727.

**Circle No 371**

## PC ADD-INS

- *Provide 24 or 48 analog input channels*
- *Digitize to 12-bit+sign resolution*

The AIP-24 and AIP-48 analog input boards for the IBM PC and compatibles provide you with 24 differential channels and 48 single-



ended channels, respectively. The boards feature 12-bit A/D conversion with a separate sign bit; they provide 0.0125% resolution. You use software to select the input channel and to program the gain of the input amplifier to ×1, ×10, ×100, or

# "**EDN NEWS** TARGETS THE PROFESSIONALS OUR CLIENTS NEED TO HIRE."

*Sue Katalinas*
*Tampa Regional Manager*
*Nationwide Advertising Service, Inc.*

**"And they keep coming back to EDN News to get** qualified response," says Sue Katalinas, Tampa Regional Manager for Nationwide Advertising Service, Inc.

Sue works with many high-tech electronics companies who rely on their national recruitment advertising to bring top talent to Florida. Her clients are impressed by only one thing. Results.

That's why she recommends EDN News.

"EDN News generates outstanding results with its combination of targeted market penetration, special editorial, and high-quality production. Plus, EDN News provides quality response for the right price. EDN News is cost-effective; it's that simple!"

Will she stick with EDN News?

"Positively. As the Florida market continues to grow, we will continue to recommend EDN News as a vital part of our clients' recruitment advertising programs."


Advertising in EDN News works for Nationwide Advertising Service. It can work for you.

**EDN NEWS**

***Where Advertising Works***

$\times 1000$; input ranges are between $\pm 10$ mV and $\pm 10$V full scale. The A/D converter has a conversion period of 25 μsec, and the board can achieve a sample rate of 20k samples/sec. Its control, status, and data-output registers are mapped into the PC's I/O space. Sample programs, written in GW-basic and Turbo Pascal, come with the boards. Each board costs £395.

**Blue Chip Technology Ltd,** Main Ave, Hawarden Industrial Park, Deeside, Clwyd CH5 3PP, UK. Phone (0244) 520222. TLX 61471.

**Circle No 372**

## GRAPHICS WORKSTATION

- *Workstation is plug compatible with an IBM 5080 mainframe*
- *Meets NACSIM 5100A Tempest standards*

The DS 1082GXT is a plug-compatible graphics workstation that allows users to run IBM 5080-based applications software such as CADAM and CATIA without modification. It is a raster-scan graphics system that provides 1024×1024-pixel resolution in 256 colors with 3-dimensional transforms. The single-board design conforms to the NACSIM 5100A Tempest standards. The system includes a graphics controller, a 19-in. monitor, a keyboard, and 512k bytes (expandable to 4M bytes) of display memory; it's compatible with IBM 5080 graphics terminals and is optionally compatible with IBM 3270 terminals. One design-set communications controller can handle as many as 64 terminals. The host interfaces are RFI shielded. $29,900.

**Spectragraphics Corp,** 9125 Rehco Rd, San Diego, CA 92121. Phone (619) 450-0611.

**Circle No 373**

## LOGIC ANALYZER

- *Turns an IBM PC into a 100-MHz logic analyzer*
- *Costs much less than most logic analyzers*

The CLK 2400 plug-in board turns an IBM PC or compatible computer into a logic analyzer. It can be configured to compare 24 channels of

digital data at 25 MHz with a memory depth of 1024 bits/channel. In the high-speed mode, it can sample six channels of data at 100 MHz with a memory depth of 4096 bits/channel. It features a 24-bit-wide trigger word; an external trigger enable; an external clock qualifier; a single pod; rising- and falling-edge clocking; triggering on 0, 1, or don't-care bit patterns; user-specified waveform labels of as many as five characters; and a display that indicates the time between cursors A and B. $1495.

**Advanced Computer Instruments,** Box 855248, Richardson, TX 75085. Phone (214) 690-4952.

**Circle No 374**

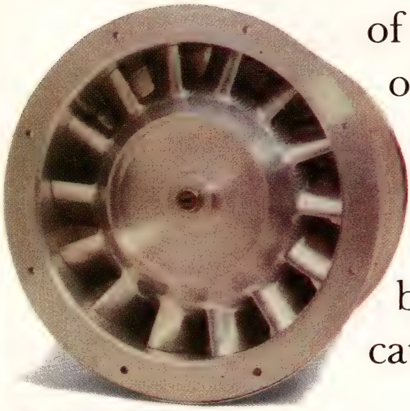
## 1-BOARD COMPUTER

- *Single 9U Eurocard contains CPU, memory, and I/O*
- *SBC is configured for high-performance multitasking systems*

The CY4110 is a VME Bus single-board computer on a 9U×280-mm

# The Large Vaneaxials of Reliability

When you need lots of air from a thoroughly reliable, uncompromisingly rugged source, trust the Maxiax line of 4″ to 13.5″ vaneaxial fans from the Custom Division of EG&G Rotron. With airflows between 275 and 2400 CFM, Maxiax fans are built to the industry's tightest specifications, for use in applications from avionics cooling to personnel compartment ventilation.



Like all fans, blowers and motors built by the Custom Division of EG&G Rotron, the Maxiax large vaneaxials are custom-designed to your precise specifications, individually engineered, prototype tested and quality control certified. And when they're built, they're constructed of the finest materials available by the airmoving industry's most experienced manufacturer. The high-powered, high-reliability, high-efficiency Maxiax line of large vaneaxial fans from the Custom Division of EG&G Rotron: where reliability is a way of life.

**EG&G ROTRON**
**Custom Division**
ROTRON INC., Woodstock, N.Y. 12498
TEL. (914) 679-5201 TWX: 510-247-9033

For our new Maxiax brochure, call (800) 431-6033. In NY State and for technical assistance, call (914) 679-5201.

CIRCLE NO 179

# Our newest military 1 MHz DC-DC converter: built for critical environments

**The Power Technology Group of Inland Motor continues to advance the technology in high density Military power conversion.**

We have improved our benchmark 1 MHz, zero current switching forward converters for even more demanding applications. We call our new line the RC/RB series of converters and power boosters. This new line now offers as standard features:

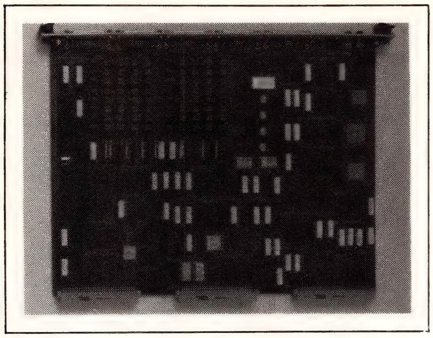
- All hermetically sealed semiconductors
- 28 VDC input per MIL-STD-704D & MIL-STD-1275A
- 270 VDC input per MIL-STD-704D
- Vacuum molded case for higher stress levels of MIL-E-5400, MIL-S-901, MIL-STD-202 & MIL-STD-810
- Improved thermal characteristics for −55°C to +85°C operation
- Environmental Stress Screening including power ageing the thermal cycling

Have we had to sacrifice size to achieve these improvements? Not at all. In fact we have actually reduced the module envelope. Now a full 100W of regulated and isolated DC power is available in only 4 in.$^3$ (4.6″L x 2.0″W x 0.485″H). Join the growing list of users who have given their military systems the competitive advantage of Inland's 1 MHz power technology. Find out what Inland can do for you by calling (602) 459-1150.


**Power Technology Group**
**Inland Motor**
A Division of Kollmorgen Corp.

4020 E. Inland Road, Sierra Vista, AZ 85635
Phone: 602-459-1150 • TWX: 910-973-9869

CIRCLE NO 178



Eurocard. The large format integrates the following features: a 68020 CPU (in 12.5-, 16.67-, or 20-MHz versions), an optional 68881 floating-point coprocessor, an optional 68851 paged MMU, 2M or 4M bytes of dual-ported dynamic RAM with parity, four 28-pin JEDEC ROM/static-RAM sockets configured as a 32-bit memory, one 28-pin JEDEC ROM socket for the monitor/debugger, a 68440 2-channel DMA controller, a floppy-disk controller, a SCSI interface, a parallel printer port, four RS-232C ports, a 24-bit counter/timer and real-time clock, and a VME Bus master/slave interface (A32, D32). In parallel-processing systems, the board allows the 68020's local resources to be truly local, reserving the system bus for global communications and system resources. 12.5-MHz version with 2M bytes of dynamic RAM, $5700; 20-MHz version, $6100.

**Cyclone Microsystems,** 25 Science Park, New Haven, CT 06511. Phone (203) 786-5536.

**Circle No 375**

## PARALLEL I/O BOARD

- *Forty-eight I/O lines organized as six 8-bit I/O ports*
- *Each port is independently programmable*

The MS-PIO is a single-height VME Bus board whose two 50-pin headers provide 48 I/O lines that are organized as six 8-bit I/O ports. Each header can interface to a 24-channel I/O rack. Each I/O port can sink 24 mA. An output control register (OCR) defines the data direction of each port. The OCR provides three advantages: It allows you to configure the board's I/O ports independently as inputs or outputs under software control; it can dynamically reconfigure each port for bidirectional control; and it lets you determine the port direction for all six ports by reading the OCR. The board is fully compatible with revision C.1 of the VME Bus specification. It is an A16:D8(O) slave that requires a 128-byte block of the VME Bus's short-address space. The Data Strobe (DSO) low to DTACK low is 135 nsec max for all read/write cycles. $345.

**Matrix Corp,** 1203 New Hope Rd, Raleigh, NC 27610. Phone (919) 833-2000.

**Circle No 383**

## CRT TERMINAL

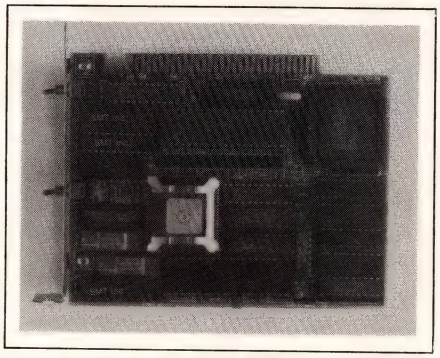
- *Can be connected to two hosts for dual-session operation*
- *Features a flat-screen display and a keyboard with 108 keys*

The CIT310 is a DEC-compatible alphanumeric terminal that can be connected to two hosts for simultaneous dual-session operation. When the terminal is in dual-session mode, you can split the screen horizontally and select the percentage of display for each session. Each host can also have independent 24-row screen displays that you toggle by pressing the mode/session key. When the terminal is in dual mode, one session can have a 132-column display for spreadsheet data while the other has an 80-column display for word processing. The terminal's 14-in.-diagonal, flat-screen display is available in white, amber, or green phosphors. The keyboard has 108 keys, 45 of which are function keys. The smart terminal can store four pages of screen information or 100 lines locally. You can allocate the memory entirely to one session or split it evenly between dual sessions. $749.

**CIE Terminals Inc,** 2505 McCabe Way, Irvine, CA 92714. Phone (714) 660-1421.

**Circle No 376**





## IBM PC/XT ACCELERATOR

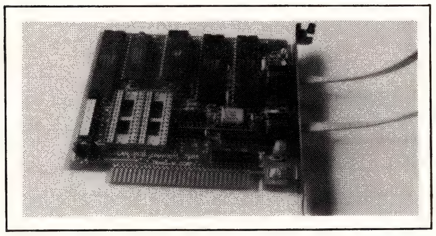
- *Add-in card boosts the IBM PC/XT's performance*
- *Accelerates computations for Autocad and Microsoft Windows*

The XT-286 Speed Card is a half-slot, add-in board for the IBM PC/XT. It has an 80286 µP that runs at 10 MHz and a cache memory that has zero wait states. The board gives the IBM PC/XT better performance than the IBM PC/AT. It achieves acceleration by means of the 8k-byte cache memory rather than via an increase in clock speed. Should a particular piece of application software present a compatibility problem, you can disable both the 80286 and the cache memory with an outside switch. The board runs with Autocad and Microsoft Windows. Autocad users can employ either a 6- or 10-MHz 80287 coprocessor. When tested under the Norton Utilities System Information program, the vendor claims, a 4.77-MHz IBM PC/XT using the card

receives a rating of 7.8; an IBM PC/XT without the card has a rating of 1.0. An 8-MHz Turbo XT clone with the card is rated at 9.4; without the card, that computer achieves 1.7. An 8-MHz IBM PC/AT has a rating of 7.7. $499.

**SMT Inc,** 1145 Linda Vista Dr, San Marcos, CA 92069. Phone (619) 744-3590.

**Circle No 377**



## IBM PC LAN

- *Easily installed network connects as many as 127 IBM PCs*
- *Provides a low-cost alternative for low-end PC users*

The NET-127 is a relatively inexpensive local-area network (LAN) for IBM PC, PC/XT, and PC/AT users. Designed for the general office environment, it can handle data transmission between nodes at distances to 1000 ft. You can connect as many as 127 users via easily installed telephone wire or twisted-pair cable. The protocol is proprietary and is similar to Ethernet with CSMA/CD. You can daisy-chain peer-to-peer or host-to-remote communications at transmission rates of 250k bps. The network runs most MS-DOS-supported software, such as Lotus 1-2-3, dBase III, and WordStar. The operating system occupies 35k bytes of RAM. The vendor provides a software interface for most common programming languages, such as Assembler, C, Pascal, Basic, and Fortran. Access classes, passwords, or station-sensitive selective-access privileges control read/write access. $249.95.

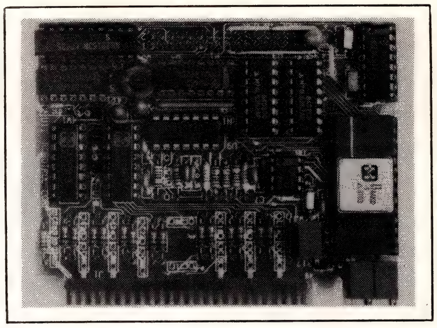
**Trans-M Corp,** 28 Blacksmith Dr, Medfield, MA 02052. Phone (617) 359-5144.

**Circle No 378**

## ANALOG INPUT CARD

- *Offers eight differential or 16 single-ended analog inputs*
- *Single-width SBX module has 12-bit resolution*

The RBX311 is an analog input card with a standard 36-pin male SBX connector. The analog inputs have 12-bit resolution and can be config-



ured as 16 single-ended or eight differential voltage inputs. The input section has an instrumentation amplifier and an S/H amplifier. You can accommodate full-scale ranges from 50 mV to 10V by changing a single resistor. You begin conversion by writing one byte to the card, indicating the input channel to be converted. You determine the completion of conversion by polling status bits or generating an interrupt. The card's throughput rate is 30 kHz typ; a high-speed option increases the rate to 50 kHz typ. The analog inputs are protected to ±32V; protection to 100V rms is optional. Analog input takes place through a 50-pin edge connector. Each of the analog inputs has space for user-installed lowpass filters for noise reduction. $495.

**Robotrol Corp,** 16100 Caputo Dr, Morgan Hill, CA 95037. Phone (408) 778-0400.

**Circle No 379**



## IBM PC/AT ACCELERATOR

- *16-MHz 80386-based board triples IBM PC/AT's speed*
- *Board is compatible with add-on hardware and software*

The 16-MHz 386 Express is a low-cost 80386-based accelerator for the IBM PC/AT. The board triples the PC/AT's speed while maintaining compatibility with add-on hardware and software. It provides hardware compatibility by using the system's native 80286 processor during the boot sequence and by subsequently switching to the 80386 during application processing. It provides software compatibility by allowing for keyboard control of the 80386/80286 processor selection. The board enhances program execution with 16k bytes of software-selectable, zero-wait-state cache memory. It has a 32-bit-wide data bus, and it can handle all the speeds of an 80287 coprocessor. When tested under the Norton Utilities System Information program, the board's highest rating was 18.7, as compared to a rating of 7.7 for the 8-MHz IBM PC/AT and a rating of 1.0 for the standard 8088-based IBM PC/AT. $1195.

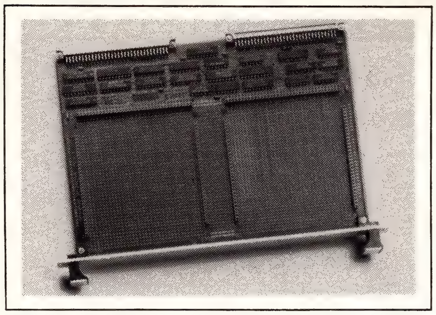
**PC Technologies Inc,** Box 2090, Ann Arbor, MI 48106. Phone (800) 821-3086; in MI, (313) 996-9690.

**Circle No 380**

## PROTOTYPING BOARD

- *Has an onboard VME Bus interface*
- *Supports the implementation of dual-port RAM*

The SP-Proto double-Eurocard VME Bus board provides you with a ready-made VME Bus interface, and a wrap-and-wire area in which



you can prototype custom VME Bus boards. The module's VME Bus (Rev C) interface handles all VME Bus timing and control signals, address decoding, data-bus control, DTACK generation, and interrupt-request and interrupt-vector generation. All processed VME signals are available on two duplicated connectors, and you can implement a P2 expansion bus. The interface accepts three positive-edge-triggered onboard interrupts, routing them on a single VME Bus interrupt level with different interrupt vectors. You can program the interrupt level and the vectors used. You can also implement dual-port RAM on the board without having to add extensive arbitration logic. $613.

**NV Spinnov SA,** Pleinlaan 2, Building K6, 1050 Brussels, Belgium. Phone 02-641 2844. TLX 61051.

**Circle No** 381

## PERSONAL COMPUTER

- *32-bit memory bus can access 24M bytes of RAM*
- *32-bit 80386 µP operates at 16 MHz*

The 16-MHz WysePC 386 Model 3216 computer has a zero-wait-state memory that accommodates CAD, network file serving, and multiuser/multitasking processing. The 32-bit 80386-based computer is compatible with the IBM PC and PC/AT and can run Unix, Xenix, and MS-DOS 3.2. It can run time-sensitive applications at 8 MHz. The computer has nine expansion slots and a dedicated 32-bit memory bus that can access as much as 24M bytes of RAM. The vendor offers five half-height, 5.25-in. shelves for mass-storage devices, four of which are accessible from the front panel. The computer provides software emulation of the Lotus/Intel/Microsoft (LIM) Expanded Memory Specification (EMS) and the AST Enhanced EMS, allowing programs such as Lotus 1-2-3 and Framework to access memory in excess of 640k bytes. WY-3216-01, with single floppy-disk drive, $3799; WY-3216-40, with 40M-byte hard-disk drive, $4999.

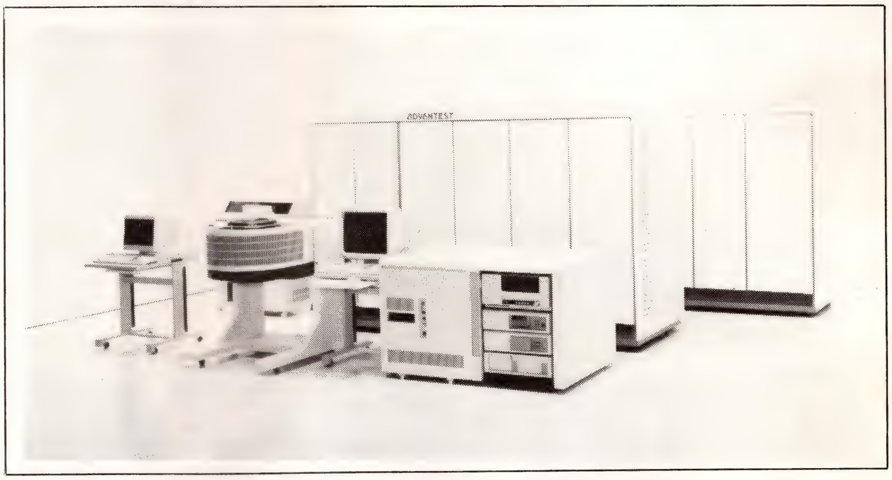
**Wyse Technology,** 3571 N First St, San Jose, CA 95134. Phone (408) 433-1000. TLX 3719730.

**Circle No** 382

## TEST & MEASUREMENT INSTRUMENTS

### VLSI TESTER

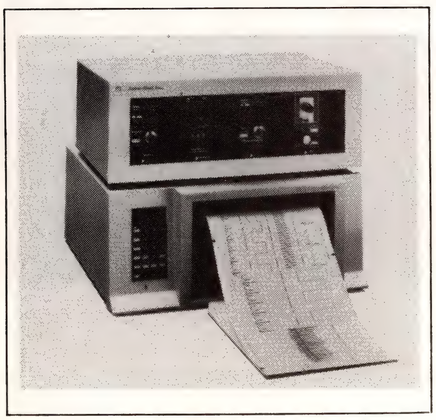
- *Tester has 512 pins*
- *Employs two computers*



The T3381 device tester has 512 test pins. It supports either a 75-MHz general-purpose AG test head or a 100-MHz ECL AE test head. You can double the tester's clock speeds by multiplexing its test pins. The AG test head's overall timing accuracy is ±500 psec; the AE's is ±400 psec. The tester incorporates two computers: a general-purpose host computer, which you program in conventional languages, and a special-purpose computer, which runs the tests and which you program in a proprietary language. The unit's 256k-word vector memory stores 3 bits/word for each pin. From \$3,000,000 to \$6,000,000.

**Advantest America Inc,** 300 Knightsbridge Parkway, Lincolnshire, IL 60069. Phone (312) 634-2552.

**Circle No 419**



### THERMAL RECORDER

- *Has 1000-Hz bandwidth*
- *Records four channels*

The MT-8500-4 thermal-array chart recorder has a 1000-Hz, direct-writing bandwidth (full scale). The device requires special thermal-recording paper. It has four analog channels, each of which can write a trace measuring as much as 1.7 in. wide without overlapping (3.9 in. wide max with overlapping). Reducing the number of recorded channels allows you to widen the recorded trace to 7.9 in. wide max. You can also annotate each trace and the entire chart via front-panel controls. Modular signal conditioners and RS-232C and IEEE-488 interfaces are optional. \$7,500.

**Astro-Med Inc,** Astro-Med Industrial Park, West Warwick, RI 02893. Phone (800) 343-4039; in RI, (401) 828-4000.

**Circle No 420**

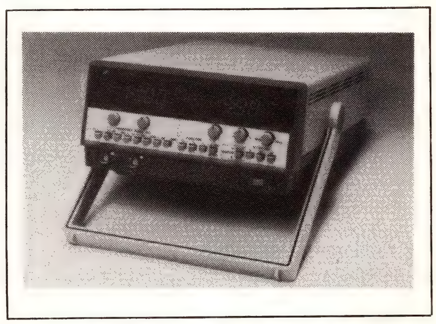
### μWAVE NOISE TESTERS

- *Perform six to 10 measurements/sec*
- *Cover frequency range of 10 MHz to 26.5 GHz*

The 2275S and 2276S microwave-noise-figure test systems cover the frequency range from 10 MHz to 26.5 GHz. Their noise-measurement range is 0 to 30 dB, and their gain-measurement range is −20 to +55 dB. Each system's input VSWR is <1.7, and both perform six to 10 measurements/sec. The 2276S provides plotter outputs. 2275S, \$46,765; 2276S, \$61,745.

**Eaton Corp,** 5340 Alla Rd, Los Angeles, CA 90066. Phone (213) 822-3061. TWX 910-343-6969.

**Circle No 421**



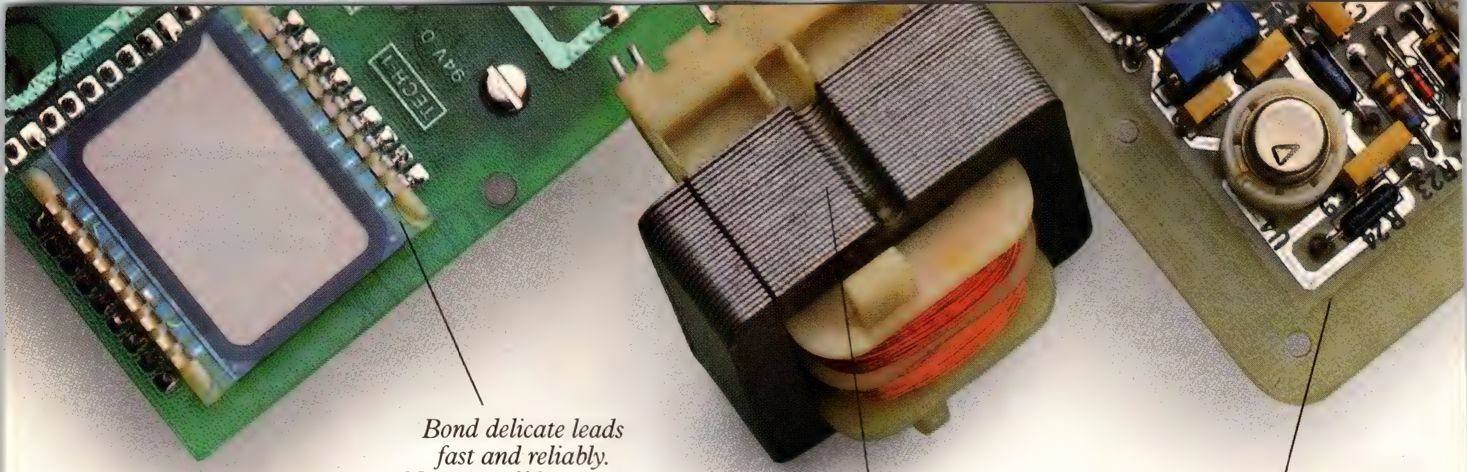
### FUNCTION GENERATOR

- *Simultaneously displays frequency and dc offset*
- *Square-wave rise time is <25 nsec*

The SG-4111 has a frequency range from 0.1 Hz to 11 MHz. The instrument generates sine, triangle, and square waves. Square-wave rise and fall times are <25 nsec. The unit supplies 20V p-p output into 50Ω. Its frequency accuracy is ±2% of programmed value, and its external voltage-controlled sweep range is 1100:1. The device has a TTL-compatible synchronous output. \$995.

**Iwatsu Instruments,** 430 Commerce Blvd, Carlstadt, NJ 07072. Phone (201) 935-5220.

**Circle No 422**



*Bond delicate leads fast and reliably. No more off-line curing to hold up assembly.*

*Unitize on-line in 20 seconds. No drilling, no precoating, no heating. Hum-free performance.*

*Coat and cure in 2 minutes, not hours. The only UV coating that meets MIL-I-46058C for long-term durability.*

# BOND, SEAL, COAT AT THE SPEED OF LIGHT.

**Loctite UV Systems.** Loctite has the widest selection of UV products and dispensing and curing equipment in the business. For most volumes and applications, we offer an off-the-shelf solution. For unique applications, our custom-design team is ready to engineer the cost-effective system that's just right for your needs.

**Free cost/benefit analysis.** Loctite UV products and equipment will cut costs throughout your assembly. And improve quality. And boost output. Make us prove it. Call Loctite's Electronic Division at 203-246-1223 and we'll shed some light.

LOCTITE®

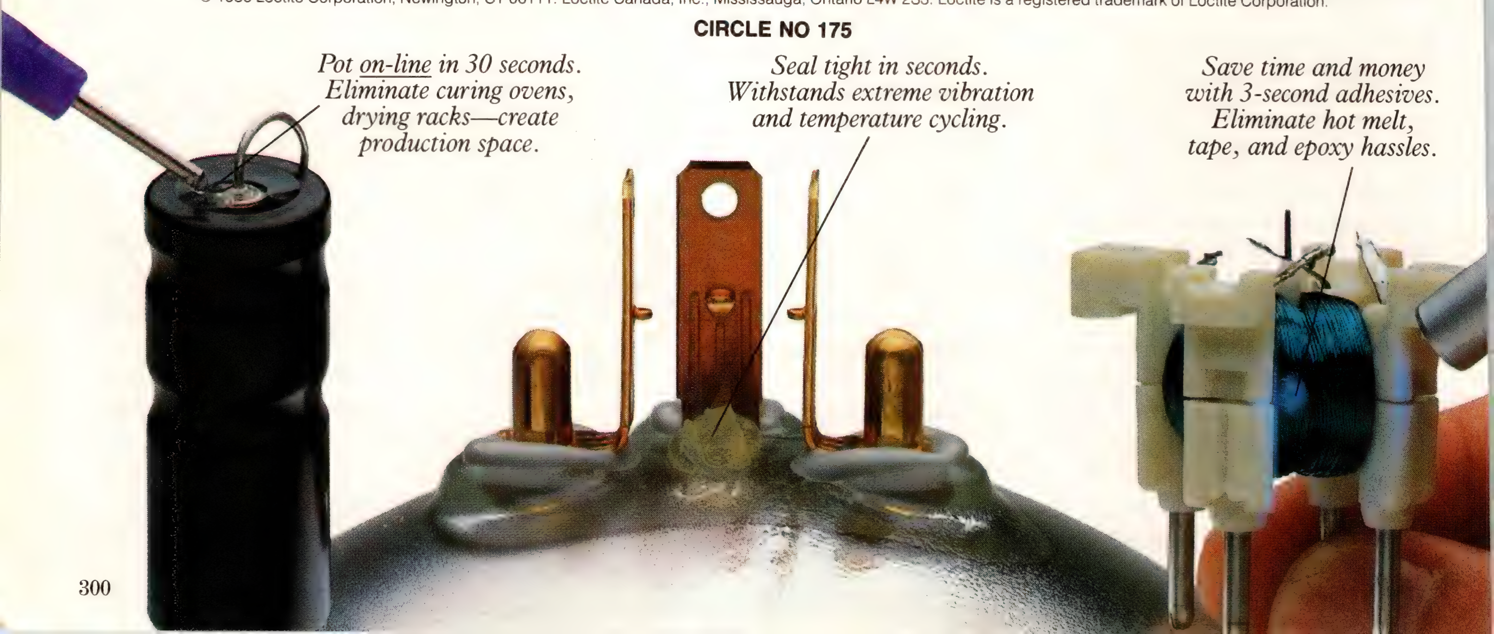


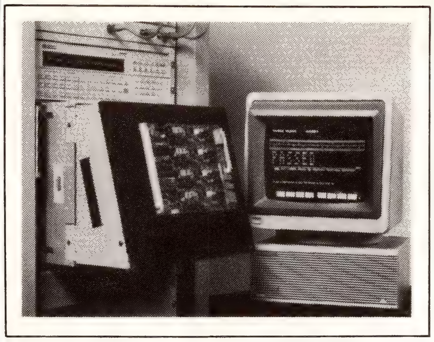
**CIRCLE NO 175**

*Pot on-line in 30 seconds. Eliminate curing ovens, drying racks—create production space.*

*Seal tight in seconds. Withstands extreme vibration and temperature cycling.*

*Save time and money with 3-second adhesives. Eliminate hot melt, tape, and epoxy hassles.*





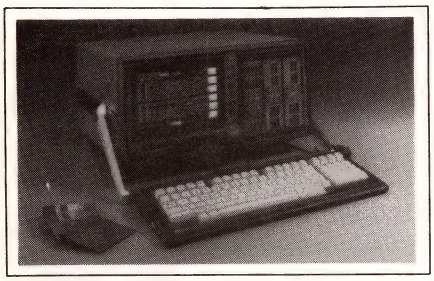
## TEST FIXTURE

- *Bed-of-nails fixture carries 320 test contacts*
- *Has 1.3-GHz bandwidth*

The HP 34597A pc-board test fixture suits IEEE-488 rack-and-stack test systems. The device is a vacuum, bed-of-nails, single-sided fixture with 320 contacts. It has gold-plated pogo pins. If you use coaxial cables to connect the board under test to your test equipment, the fixture's maximum bandwidth is 1.3 GHz. The pins are on 50-mil centers suitable for SMD probing. HP 34597A basic fixture, $600; quick-interconnect option 590, $750.

**Hewlett-Packard Co,** Inquiries Manager, 1820 Embarcadero Rd, Palo Alto, CA 94303. Phone local office.

**Circle No 423**



## LOGIC TEST SYSTEM

- *Has logic-analysis and pattern-generation facilities*
- *Accommodates as many as 192 logic-analyzer channels*

The M128 logic-test system comprises a mainframe into which you can plug as many as three units from a range of logic-analysis and pattern-generation modules. The mainframe is based on a computer architecture that runs Digital Research's MP/M II operating system. It provides two 3½-in. floppy-disk drives and an optional 20M-byte hard-disk drive for data storage, and it has a full ASCII keyboard. The range of plug-in modules includes logic-analysis units with 16 to 64 50-MHz channels, 16 to 64 100-MHz channels (reconfigurable to provide eight to 32 200-MHz channels), or 16 300-MHz channels. The vendor also offers a module for serial-link data analysis and a 48-channel, 4000-word, 20-MHz pattern-generator module. The analyzer has 15 trigger levels and provides for as many as 60 trigger functions. The instrument comes with RS-232C, Centronics, and IEEE-488 interfaces. From $10,000 to $25,000.

**Dolch Logic Instruments GmbH,** Justus-von-Liebig-Strasse 19D, 6057 Dietzenbach, West Germany. Phone (06074) 40020. TLX 4191550.

**Circle No 424**

**Dolch Logic Instruments Inc,** 2029 O'Toole Ave, San Jose, CA 95131. Phone (408) 945-1881. TWX 910-338-2023.

**Circle No 425**

## LCR BRIDGE

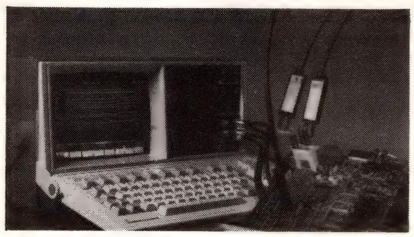
- *Interfaces to an IBM PC*
- *Provides statistical data on component values*

Linked to an IBM PC or compatible computer via a National Instruments IEEE-488 interface card, the LCR451 component-measuring bridge and its associated software package allows you to measure the major and minor terms of complex impedances. In addition, you can sort batches of more than 500 com-

ponents according to preset band limits. You can log the results and calculate statistical information, such as mean value, standard deviation, and variance coefficients. You can also edit the results to include or reject components that fall outside preset limits. LCR451 component bridge, £995; software package, £195.

**Prism Instruments (Aimtest) Ltd,** Burrel Rd, Industrial Estate, St Ives, Huntingdon, Cambs PE17 4NF, UK. Phone (0480) 62225.

**Circle No 426**



## ANALYZER OPTION

- *Provides eight 400-MHz logic-analyzer channels*
- *Includes a glitch filter to prevent spurious triggering*

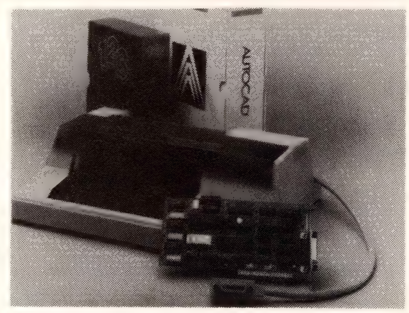
The LAS-B8 option for the company's LAS logic analyzer provides you with eight input channels that can operate at internal clock frequencies as high as 400 MHz. You can externally clock the inputs at frequencies as high as 100 MHz. The trace memory is 4000 words deep, and you can capture pre- or post-trigger data. The analyzer option's 2-level triggering operates to the maximum clock frequencies, and it incorporates a selectable glitch filter at the first level to avoid spurious triggering. The mainframe LAS analyzer lets you perform simultaneous state/timing traces. The vendor also provides four low-input-capacitance, active probes, which connect the option to the circuit under test; you can vary the probes' threshold over the ±9.9V range. Approximately DM 16,000.

**Rohde & Schwarz GmbH & Co KG,** Muhldorfstrasse 15, 8000 Munich 80, West Germany. Phone (089) 41290. TLX 523703.

**Circle No 427**

**Rohde & Schwarz-Polarad Inc,** 5 Delaware Dr, Lake Success, NY 11042. Phone (516) 328-1100. TWX 510-223-0414.

**Circle No 428**



## PRINTER INTERFACE

- *Links IBM PC to IEEE-488 printers and plotters*
- *Works with software that bypasses DOS*

The COM488 pc board plugs into an IBM PC and provides a bidirectional link to IEEE-488-compatible printers and plotters. The board requires no special drivers to redirect serial output. Programs that bypass conventional DOS I/O calls will work with the board. The board operates transparently, emulating a standard IBM PC serial port while its onboard processor converts data intended for a serial device to the IEEE-488 protocol. The board has a 32k-byte buffer. $495.

**IOtech Inc,** 23400 Aurora Rd, Cleveland, OH 44146. Phone (216) 439-4091.

**Circle No 429**

## TROUBLESHOOTER

- *Unit links one pin at a time to a scope*
- *Instrument scans digital ICs*

The Model 5700C incorporates a logic-state indicator, logic pulser, logic-device clip, automatic intermittent level detector, autoranging DVM, and device-to-scope interface in a

# RAPID SYSTEMS ANNOUNCES A NEW, HIGH-SPEED PC-BASED DIGITAL OSCILLOSCOPE!


## THE FASTEST, LARGEST DATA-BUFFER 2-CHANNEL OSCILLOSCOPE FOR THE PRICE: ONLY $3495.

The R2000 PC-based digital oscilloscope features 2 input channels, each with its own 20Mhz A/D converter and 65,535 8-bit byte data buffer. No other turn-key instrument offers a higher sample rate or deeper buffer size for the price: only $3495.

### Highest Sample Rate Per Channel For The Price.

The R2000 allows a sample rate for *each* channel to be as high as 20Mhz. Most other instruments divide the sample rate among the number of channels, reducing the sampling rate substantially.

### Advanced Instrumentation Features Few Other Scopes Offer.

- ☐ The R2000 is an outboard peripheral with a full EMI-protected metal case for signal integrity.
- ☐ Self-contained power supply. You don't depend on your computer's supply.
- ☐ Switchable 50 ohm input with warning light to measure low impedance signals without degradation.

### Standard Oscilloscope Features You Might Only Expect In A Standalone Instrument.

- ☐ 1 Meg ohm 30 pf input impedance
- ☐ BNC input connector
- ☐ AC or DC coupling of the signal
- ☐ Diode-protected input
- ☐ Fuses for ground protection
- ☐ Input protection to +/−300 volts
- ☐ Software-selectable gain ranges from 10mv/div to 50v/div
- ☐ Full analog triggering with analog trigger input BNC
- ☐ Trigger adjust potentiometer

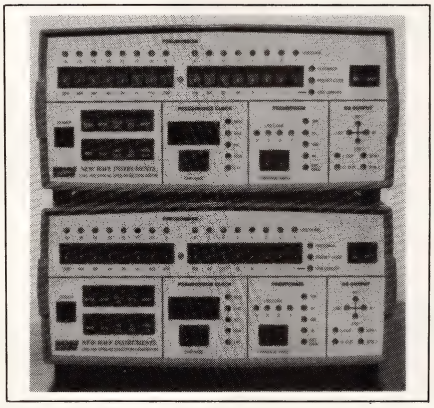

For your free copy of the Rapid Systems PC-based instrumentation catalog, to order, or for further information, call or write Rapid Systems, 433 N. 34th St., Seattle, WA 98103. (206) 547-8311. Telex: 265017UR.

RAPID SYSTEMS

single unit. The instrument features pushbutton, 1-sec scanning of an IC's pins. The level detector automatically catches static or dynamic failures. A buffer amplifier supplies a given pin's signal to an external oscilloscope. The built-in logic pulser can stimulate the device under test. Also included in the price is the Model 150 device comparator, which compares a known-good device to the device under test. $1695.

**Information Scan Technology,** 487 Gianni St, Santa Clara, CA 95054. Phone (408) 988-1908.

**Circle No 430**



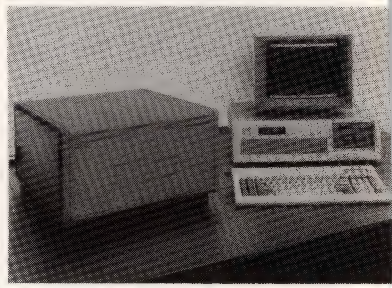
## GENERATORS

- *Generators operate to 25M bps*
- *Outputs combine for BPSK code sequences*

The LRS-100/2 system consists of two identical, linear-recursive, pseudorandom generators. The generators operate synchronously to 25M bps. You can set one generator's feedback pattern, sequence starting point, and sequence length independently of the other's. You can combine the two outputs to make a BPSK (binary phase shift keying) Gold Code sequence as long as $2^{16}-1$ bits or a Jet Propulsion Lab sequence as long as $4.3\times10^9$ bits. You can use the two sequences separately for QPSK (quadriphase shift keying) applications. Each generator comes with its own internal clock and a fixed pseudorandom sequence. Their outputs include a buffered clock, data, sequence strobes, I and Q direct sequences, and a parallel interface to drive a frequ cy hopper. $9000. Delivery, stock two months.

**New Wave Instruments,** 37 Masters Ct, San Jose, CA 951 Phone (408) 629-3105. TWX 5 601-2474.

**Circle No 4**



## DEVICE ANALYZER

- *Uses electro-optic technique to achieve 100-GHz bandwidth*
- *Tests electro-optic and fast elec tronic devices*

The Model 8300 electro-optic wav form analyzer has a 100-GHz ban width and a 4-psec response tim Using an IBM PC for analysis a control, it measures the electric characteristics of ultrafast and opt electronic devices. The instrume employs a photoconductive switch generate an extremely fast electr cal stimulus signal, and it uses a electro-optic sensor to measure th electrical response of the devic under test. To test a device, yo wire-bond it to a coplanar wav guide on a glass slide. $90,000.

**EG&G Princeton Applied Re search Corp,** Scientific Instru ments Div, Box 2565, Princeton, N 08543. Phone (609) 452-2111. TL 843409.

**Circle No 43**

## FUNCTION GENERATORS

- *Series includes eight instruments*
- *Six instruments come with frequency counters*

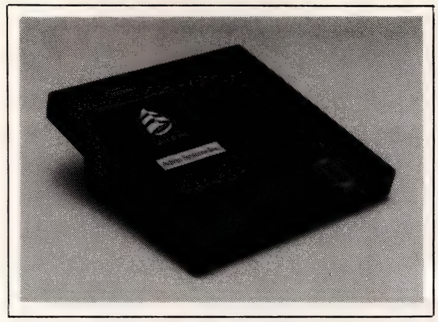
The 300 Series pulse/function gene

rators comprise eight 5.5-MHz models. The instruments generate sine, triangle, sawtooth, and square waves. Six of the models come with 100-MHz frequency counters. Each instrument can provide attenuation of 90 dB and dc offset of ±10V. The generator's output is 20V p-p into 50Ω. Options for the instrument include an internal/external trigger, gate and burst capability, external synchronization, linear and logarithmic sweep, markers, external AM and FM, and a frequency synthesizer. $599 to $1399. Delivery, stock to six weeks ARO.

**Elpaz Instruments Inc,** 160 N Craig St, Pittsburgh, PA 15213. Phone (412) 687-8700. TLX 382960.

**Circle No 433**





## PLD PROGRAMMER

- *Requires no personality adapters*
- *Hooks to printer port of IBM PC, PC/XT, and PC/AT*

The Sailor-PAL is a universal PLD programmer that requires no personality adapters. It handles 20-, 24-, and 28-pin devices. Instead of using a special adapter card, the unit attaches directly to the printer port of an IBM PC, PC/XT, or PC/AT. You use IBM PC software to program PLDs interactively or in batch mode. A single PC can control as many as three programmers. $1095.

**Advin Systems Inc,** 1050-L E Duane Ave, Sunnyvale, CA 94086. Phone (408) 984-8600. TWX 510-600-5624.

**Circle No 434**

## POWER SCOPE

- *Oscilloscope is designed for high-power measurements*
- *Front-panel LED display shows phase angle*

The 881 Powerscope II is a 5-channel oscilloscope that's specifically designed for high-voltage power measurements. The four main channels have isolated, differential inputs. The fifth channel is a trigger-view channel. Each channel's input connectors are isolated and protected for 1000V dc (3000V for short intervals). A front-panel LED display shows phase angle. $4995.

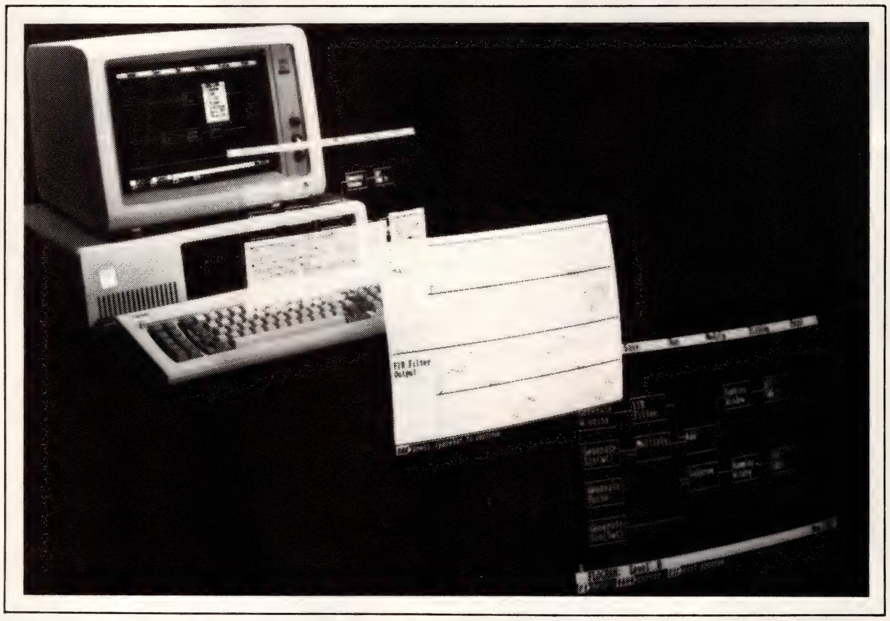
**Primeline,** Box 670, San Fernando, CA 91341. Phone (800) 525-5554; in CA, (818) 764-5400. TLX 4943094.

**Circle No 435**

## CAE & SOFTWARE DEVELOPMENT TOOLS

### DSP DESIGN TOOL

- *Lets you design and simulate DSP systems*
- *Can synthesize arbitrary signals to test your design*



DSPlay is a software package that runs on an IBM PC or compatible computer that's equipped with at least 256k bytes of RAM and a CGA or equivalent color-graphics board. The software can use (but does not require) an 8087 or 80287 math coprocessor. The menu-driven interface lets you create functional block diagrams (called FlowGrams) on the screen and define the processing that each block will perform. The menus, pullup lists, and context-sensitive help windows make it easy to enter, edit, and run DSP algorithms. Once you've developed a FlowGram, you can save any or all of the blocks for future use, and then execute the program. When debugging, you can execute a single block or execute the program only as far as a selected point. After making changes, you can continue execution from a selected point. The software lets you generate various waveforms for input to your design: These waveforms include sine and cosine waves; white or Gaussian noise; and triangular, square, or trapezoidal pulses. You can process these signals with routines that perform Fourier transforms, correlation, or convolution, as well as standard arithmetic and trigonometric functions. The programs perform all calculations in floating-point format with a 40-bit mantissa and an 8-bit exponent. The software can also work with the vendor's A/D- and D/A-converter boards. DSPlay design package, $495; DSP Educational Package, $25.

**Burr-Brown,** Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TLX 666491. TWX 910-952-1111.

**Circle No 405**

### PRINTER EMULATOR

- *Lets TurboLaser work with programs for HP LaserJet Plus*
- *Provides a variety of fonts*

LaserJet Plus Emulation Software allows users of TurboLaser printers to run more than 600 programs written specifically for use with the Hewlett-Packard LaserJet Plus printer. The programs can perform font loading, graphics generation, and high-speed printing. The software lets you use both LaserJet Plus and TurboLaser application programs with a wider variety of fonts. The emulation software runs on IBM PCs and compatibles. $149 for current TurboLaser users; free to new purchasers of TurboLaser printers.

**AST Research Inc,** 2121 Alton Ave, Irvine, CA 92714. Phone (714) 863-1333.

**Circle No 406**

### REAL-TIME OS

- *Runs on 68020- and 80386-based machines*
- *Provides a real-time, multitasking kernel*

VRTX32 is a real-time, multitasking operating-system kernel intended for use with embedded computers based on the Motorola 68020 and Intel 80386 μPs. The kernel employs a pre-emptive, priority-based scheduler that lets you create, delete, resume, and suspend tasks. It also handles all service calls, including those for task services, intertask synchronization and communication, memory allocation, real-time clock services, character I/O, and interrupt handling. You can combine the kernel with the vendor's IOX (Input-Output Executive), which provides advanced device-level I/O facilities for character, disk, and general-block peripherals. You can also combine the kernel with FMX (File-Management Executive), which implements the PC-DOS file system. The system is position-independent; it uses program-counter-relative and base-relative addressing, and you can locate it anywhere in the available address

space without modification. The vendor guarantees that interrupts-off time will never exceed 15 μsec on a 16.7-MHz 68020 processor. Versions are available for 68000, 68010, 68020, and 80386 μPs; $6775 each.

**Ready Systems,** Box 61029, Palo Alto, CA 94306. Phone (800) 228-1249; in CA, (415) 326-2950. TLX 711510608.

**Circle No 407**

**Ready Systems SARL,** 16 bis Rue Grange Dame Rose, 78140 Velizy-Villacoublay, France. Phone 33-1-3946-89-86.

**Circle No 408**

## MICROWAVE DESIGN

- *Analyzes impedances of coaxial cables from dimensions*
- *Calculates insertion-loss vs frequency*

CXline is an addition to the vendor's line of RF/microwave CAE software. It runs on any system that uses the PC-DOS or MS-DOS operating system. The program can identify the dimension of a coaxial cable that has the most influence on the impedance of the circuit under design, so that you can specify the appropriate tolerances on the fabrication drawings. The program can calculate the dimensions of a coaxial cable that will yield the impedances you want, or it can analyze the impedances for a given set of dimensions. It can analyze the sensitivity of the cable to incremental changes in the diameter of the inner conductor, the diameter of the outer conductor, and the dielectric constant. It can also calculate insertion losses caused by each of the above parameters vs frequency. The program can calculate the higher-order-mode cutoff frequency, the capacitance and inductance per unit length, and the peak-power-handling capacity for a given cable cross-section. $235.

**Microwave Software Applications Inc,** Box 1736, Norcross, GA 30091. Phone (404) 441-9193.

**Circle No 409**

## EQUATION PROCESSOR

- *Lets you enter equations from keyboard or data file*
- *Displays results on screen or pen plotter*

Libra is an equation-processor program that runs on IBM PCs and compatibles. Its built-in editor lets you name and enter a multiline equation in symbolic format, using standard operator symbols. The program prompts you to identify the variables, which it extracts automatically, and the known constants, for which it searches in a library of standard constants. If the editor fails to find a constant that you've identified, it prompts you for a value. You can now save the equa-

tion in a named file. You can plot the results of the evaluation on the screen or on a pen plotter. The program automatically selects ranges for the axes and labels them. Because output data is automatically sent to a temporary or permanent file, it doesn't have to be re-evaluated every time you ask for a plot. $99.

**Pulse Research,** Box 696, Shelburne, VT 05482. Phone (802) 985-2928.

**Circle No 410**

## TELECOM SOFTWARE

- *Lets you conduct two telecom sessions simultaneously*
- *Built-in programming language*

Smartcom III is a stand-alone communications program that lets you use an IBM PC or compatible computer with 2400- and 9600-bps modems. The program's enhancements include a menu-driven interface and a programming language that lets you automate complex communications activities and unattended operations. It conducts two separate sessions simultaneously using both COM ports, and it can emulate several standard terminals. The program has an integrated text editor and a file-compression and/or scrambling buffer. For file transfers, you can use any of the XModem or YModem protocols or the Kermit protocol. $249.

**Hayes Microcomputer Products Inc,** Box 105203, Atlanta, GA 30348. Phone (404) 449-8791.

**Circle No 411**

## FORTH DSP SYSTEM

- *Runs Forth directly on TMS32020 DSP chip*
- *Lets you develop prototype DSP systems on an IBM PC*

FB-320 is a hardware/software DSP prototyping package that consists of the polyForth DSP operating system and software-development tools, and a full-length PC plug-in board containing a TMS32020 DSP chip, as well as independent RAM and I/O ports. The real-time, multitasking OS, which requires only 24k bytes of RAM, comes with an optimizing compiler that provides more than 200 primitive commands, a macroassembler for the TMS32020 processor with extensions for the TMS320C25 processor, a math library that includes fixed-point-fraction functions, a graphics utility, and two sample applications with design notes and full source code. The board comes with 24k bytes of 70-nsec RAM, and you can expand the memory to as many as 128k bytes of RAM. The board also provides 16-bit D/A and A/D converters; two separate 10-pin connectors for serial I/O, clock, and control signals; and a 50-pin expansion connector that allows you to add 12 more 16-bit I/O ports. A memory port that is shared between the DSP board and its host allows the rapid transfer of data and program code between the two. $3850.

**Forth Inc,** 111 N Sepulveda Blvd, Manhattan Beach, CA 90266. Phone (213) 372-8493. TLX 275182.

**Circle No 412**

## CAD LIBRARY

- *Predrawn electrical, chemical, and mechanical symbols*
- *Compatible with desktop publishing programs*

CAD ClipArt consists of symbol libraries and artistic images that can enhance electrical, architectural, chemical, and mechanical engineering documents prepared with various desktop publishing and word-processing packages. The images are compatible with the vendor's Windows Draw, Windows Graph, and IN*a*Vision packages, as well as Microsoft's Windows Write, Palantir's Filer, and PC PageMaker from Aldus. Because the images are object oriented rather than pixel

oriented, they are device independent, and you can use your output device's maximum resolution—300 dots/in. on the HP LaserJet Plus and Apple LaserWriter, and 2540 dots/in. on an Allied Linotype laser typesetter. The package includes an index that shows each image and its location by filename. $99.95.

**Micrografx Inc,** 1820 N Greenville Ave, Richardson, TX 75081. Phone (214) 234-1769. TWX 650-309-3890.

**Circle No 413**

## PASCAL COMPILER

- *Produces ROMable code for embedded 68000-based systems*
- *Runs under VersaDOS and System V/68 operating systems*

The Pascal-2 compiler runs on and generates code for 68000-, 68010-, and 68020-based computers. Two versions are available. One runs under the vendor's VersaDOS real-time, multitasking, multiprocessing operating system; the other runs under System V/68, which is the vendor's version of Unix System V, release 3. The compiler, which was developed for the vendor by Oregon Software Inc (Beaverton, OR), is configured so that the same package runs on any of the three µPs; you use a compiler directive to select the target machine for which the compiler will generate code. Both versions can generate code that makes use of the 68881 FPU. The compiler can generate ROMable code for both VersaDOS and System V/68 target machines; it can also generate position-independent code (PIC) and code for targets that don't have memory-management units (MMUs). System V/68 can't use PIC and doesn't run on non-MMU targets. The compiler provides new string-handling capabilities and I/O switches, and the package includes an assembler interface, an execution profiler, and several cross-reference utilities. If a run-time error occurs, the compiler's error-walkback feature generates a special listing showing (in Pascal notation) each procedure call that was performed, from the point of failure back to the main program. Each version, $2800.

**Motorola,** Microcomputer Div, Box 20912, Phoenix, AZ 85036. Phone (800) 521-6274.

**Circle No 414**

## ANALYSIS PROGRAM

- *Solves nonlinear parameter-estimation problems*
- *Provides extensive library of math functions*

MINSQ is an interactive program that lets you define models from the keyboard, or load the definition from a file, in a syntax consistent with Basic, Fortran, or Pascal. The program can accept implicit functions—that is, x defined as f(y)—or parametric functions. It can also accept models defined with definite integrals. This feature lets you estimate parameters for many functions that involve differential equations. The built-in library includes hyperbolic functions, error functions, a differentiation operator, and an integral operator, as well as the usual transcendental functions. To run the program, you need an IBM PC or compatible computer equipped with at least 448k bytes of RAM; two floppy-disk drives; and a CGA, EGA, or high-resolution graphics adapter. $179.

**MicroMath Scientific Software,** 3690 E Fort Union Blvd, Suite 204, Salt Lake City, UT 84121. Phone (801) 943-0290.

**Circle No 415**

## FILE FINDER

- *Lets you tag hard-disk files with a description*
- *Lets you search by complete or partial keywords*

The Polaris Zoo Keeper is a RAM-resident file locator. Whenever you create a new file, the program

prompts you to tag the file with as many as three freeform keywords (20 characters max) and a freeform description (40 characters max). When you want to load a file but can't remember its exact name or type, you just press the hot key (Alt/Z) to bring up the search screen, and enter the first few letters of one or more tags. The program displays the description, full tags, path, and names and types of all files that match the search criteria. You can then select the one you want by moving the cursor arrow to it and pressing the Enter key. To run the program, you'll need an IBM PC, PC/XT, PC/AT, or compatible computer equipped with at least 256k bytes of RAM; a hard-disk drive; a CGA, EGA, or Hercules graphics card; and PC-DOS 2.0 or later. The setup program requires 190k bytes; the RAM-resident program occupies 32k bytes at the top of memory. $75.

**Polaris Software,** 613 W Valley Parkway, Suite 323, Escondido, CA 92025. Phone (619) 743-7800.

**Circle No 416**

## OS EXTENDER

- *Optimizes performance of 80386-based machines*
- *Allows 8088 or 80286 programs to run on an 80386*

Control/386 is a software product that helps to optimize the overall system performance of 80386-based computers. It lets you improve the speed of disk-intensive application programs by making use of the 80386's 32-bit RAM for caching; it can also increase the speed of BIOS and EGA operations by copying the code from slow ROM devices into fast 32-bit extended-memory RAM and then executing the code in RAM. The software can emulate both the EEMS (enhanced expanded-memory specification) and LIM (Lotus/Intel/Microsoft) EMS (expanded-memory specification), and it's transparent to applications that use expanded memory. The software can also emulate undocumented 80286 instructions that are not present on the 80386, and it can conform to the 8088's 1M-byte memory limit. In systems that don't have a full 640k bytes of RAM, you can place a 32-bit memory in the 512k- to 640k-byte address space. The package also allows you to run application programs that use timing-dependent copy-protection schemes on the high-speed 80386. In short, the software helps you to design an 80386-based machine that allows programs written especially for the 80386 to make full use of that μP's high performance, and it improves the performance of programs that run under PC-DOS. The vendor supplies Control/386, customized for your particular design, on a disk. $8 to $12 (OEM qty).

**Phoenix Technologies Ltd,** 320 Norwood Park S, Norwood, MA 02062. Phone (617) 769-7020. TWX 710-345-0199.

**Circle No 417**

## SCHEMATIC ENTRY

- *Runs on IBM PC/AT and compatible machines*
- *Fully compatible with Personal Logician tools*

Entry! is a low-cost schematic-entry tool that runs on the IBM PC/AT and compatibles and creates a database that is fully compatible with the vendor's Personal Logician-286 and -386 tools. The package contains a multiwindow, multitasking OS; a schematic editor with an icon-based interface that allows you to use a 1-button mouse; two compilers that detect design errors; two utilities for creating custom reports and interfaces; a basic component library; and an asynchronous communications utility that uses the Kermit file-transfer protocol. $5000.

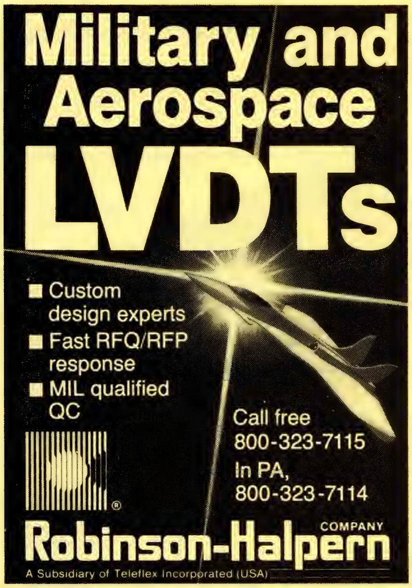
**Daisy Systems Corp,** 700 Middlefield Rd, Mountain View, CA 94039. Phone (415) 960-6593.

**Circle No 418**

# EDN PRODUCT MART

## This advertising is for new and current products.

## Please circle Reader Service number for additional information from manufacturers.




CIRCLE NO 325

**Temperature:** 820 pages cover all aspects of temperature measurement and control. Shows hundreds of probes, accessories, wire, handheld and panel readouts, controllers, recorders and computer interface equipment. Many new products have been added this year, including humidity measurement systems, and data acquisition devices.

*Call or write TODAY for more information!*

Contact:
**OMEGA ENGINEERING, INC.**
AN OMEGA Group Company
One Omega Drive
P.O. Box 4047
Stamford, CT 06907
Telephone: (203) 359-7613
Telex: 996404

CIRCLE NO 326

**EE/EPROM PROGRAMMER...with Eraser...the "BEST" for $1295.***

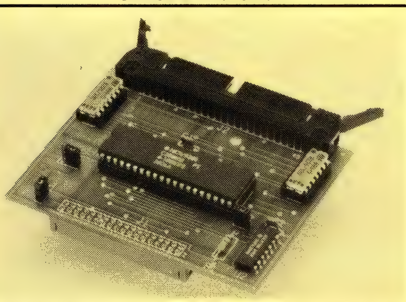
**DIGELEC Model 824**

- RAM 512K, upgradeable to 2048K
- Programs 2716 to 271024, & equivalent
- MOS, CMOS, 40-pin micro P's, no adapters
- Programs virtually all mfg's, 220 + devices
- Time-saving quick-pulse & Int. algorithms
- Complete stand-alone editing, 16-char. display
- RS-232 Remote control, translation formats
- Optional IBM-PC/AT menu-driven S.W.

* Special US Domestic Introductory Price

**digelec** PROM & LOGIC PROGRAMMERS
800-367-8750, NJ 201-493-2420.
DIGELEC, Inc., 1602 Lawrence, Ocean, NJ 07712

CIRCLE NO 327

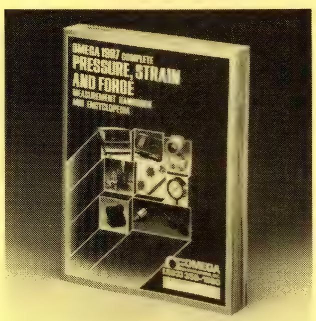


**SCSI BUS INTERFACE MODULE**

The SBSxSCSI provides the industry standard SCSI interface (ANSI X3T9.2) on a single-width SBX module. Intel iSBX™ multimodule (IEEE P959 I/O Bus) compatibility assures you of a reliable connection to your host board. A software driver example is available to simplify programming.
Call or write for more information.

**Single Board Solutions, Inc.**
20045 Stevens Creek Blvd.
Cupertino, CA 95014
(408) 253-0250

CIRCLE NO 328



**Pressure, Strain and Force:** 320 pages, with a new section devoted to pressure switches. New for 1987 are force measurement products, along with a wide selection of pressure transducers, strain gage sensors and load cell systems.

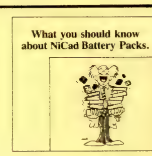
*Call or write TODAY for more information!*

Contact:
**OMEGA ENGINEERING, INC.**
AN OMEGA Group Company
One Omega Drive
P.O. Box 4047
Stamford, CT 06907
Telephone: (203) 359-7613
Telex: 996404

CIRCLE NO 329

*FREE*

**What you should know about NiCad battery packs.**




**This 12-page booklet tells you how:**

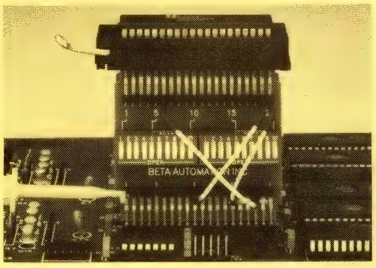
- You can make battery packs last longer
- Your storage system may be robbing battery life
- Proper disposal prevents accidents
- Why and how NiCad battery packs work
- Why today's battery packs are more reliable than yesteryear's battery packs

*Powering Your Portable World*

**Alexander Batteries**
NEW PRODUCT/OEM DIVISION
P.O. BOX 28880, SAN DIEGO, CA 92128 619-480-4445 FAX 619-480-1350

CIRCLE NO 330

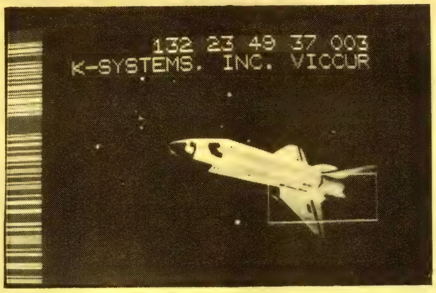
To advertise in Product Mart, call Joanne Dorian, 212/463-6415




**Bugs in your circuit?** Wasting time wrapping, unwrapping, cutting traces, bending leads? Test your ideas quickly and easily with the **DIP ISOLATOR**. Isolate any pin of a DIP IC. Use test points for rewiring. Use with emulator probe to turn off unwanted interrupts, resets. Sizes from 6 to 64 pins. Prices from $22.75.

**BETA AUTOMATION INC.**
3541 Old Conejo Rd.
Newbury Park, CA 91320
(805) 499-5785

CIRCLE NO 331

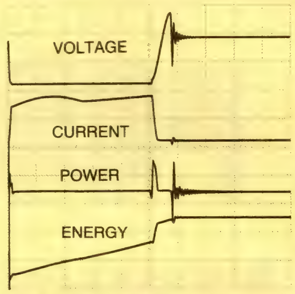



**VIDEO INSERTER WITH TITLING, GRAPHICS, AND TIMING.** The VICCUR inserts alphanumeric time code and titling and graphics, initializes its millisecond-resolution clock from IRIG-B timing, and generates one or two box or crosshair cursors. Titling, cursor and clock have battery backup. Eight analog inputs, binary video insertion, cursor readout, and keyboard input optional. RS170 (A)/CCIR/PAL. $1500 standard board; packaged versions available. **K-Systems, Inc.**, 3902 Lilac, Las Cruces, N.M. 88005, 505-526-3209. Telex: 6502763972/Ansbk: MCI

CIRCLE NO 332

## Analog Circuit Simulation

**A full featured SPICE based simulator runs on the IBM PC with interactive Input and Output**



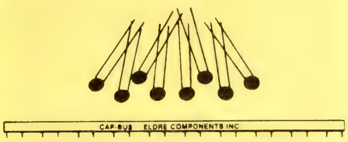

These waveforms show an IS_SPICE analysis of a power supply snubber. Intu_Scope was used for display and computation of power and energy. The output shown used an Intu_Scope plotter utility

**PRE_SPICE, $200.00**: Interactive control, Monte Carlo Analysis, Optimization, libraries and parameter evaluation.
**IS_SPICE, $95.00**: Performs AC, DC and Transient analysis.
**Intu_Scope, $250.00**: Displays, manipulates and plots data.
Programs are not copy protected, come with a 30 day money back guarantee and require PC with 640K RAM, fixed disk, coprocessor and CGA or EGA or Hercules graphics.

**intusoft**
*P.O. BOX 6607*
*San Pedro, CA 90734-6607*
*Tele: (213) 833-0710*

CIRCLE NO 333

**ELIMINATE DECOUPLING CAPACITORS**

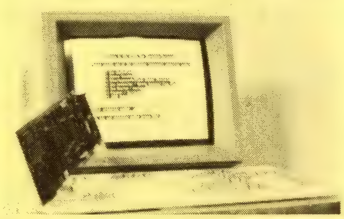



**CAP-BUS® CAPACITOR/BUS BAR**
Eliminate the decoupling capacitors and the power and ground traces from your PCB for more reliability. CAP-BUS® has a distributed capacitance of .05 micro-farads per lin. in., at 50 VDC with low inductance and low impedance. The capacitor and the bus bar have been joined together for CAP-BUS®; a more efficient capacitive decoupled power distribution system, increasing IC density on a two sided board.

**ELDRE COMPONENTS, INC.** 1500 Jefferson Rd.
Rochester, NY 14623
(716) 427-7280

CIRCLE NO 334

**1553 TESTING JUST GOT EASY**



**$4950 – PC1553 BUS EXERCISER/ANALYZER – $4950**

- IBM PC/XT/AT or compatible. Affordable complete 1533 Test Solution.
- User Friendly/Menu Driven Software. Help screen for each menu entry.
- Operating Modes include; BC, RT, Multiple RT's, Monitor/Analyzer.
- Frame Linker allows real-time conditional responses for software verify.
- Hex or ASCII Data Codes. Time Stamping for System Response Studies.
- Run Time Display/Hard Copy. 64 KWord Capture/Trace/Search Memory.
- Full Error Injection/Detection. Supports deviations to MIL-STD-1553.
- Programmable Output Amplitude. Trapezoidal or McAir Waveforms.
- Test Program Storage/Retrieval from Disk. Many Canned Test Programs.

**FREE DEMO DISK AND DATA**
**1553 TEST SYSTEMS,** 265 N. Main St., P.O. Box 748, Moscow, PA 18444-0748 717-842-1553

CIRCLE NO 335

CY525 3rd generation
STEPPER MOTOR CONTROLLER

most intelligent controller offers linear ramping, 10,000 steps/sec, unlimited stepping, change rate on the fly, read position on the fly, and much more.


CY512 compatible, 40 pin, +5 volt TTL, 8 bit I/O interface to μcomputer. $195 ea ($80/100) Prototyping board available.

Cybernetic Micro Systems
P.O. Box 3000, San Gregorio, CA 94074
(415) 726-3000 Telex: 171-135 attn: Cybernetic

CIRCLE NO 336

**FREE** CATALOG AND APPLICATIONS GUIDE

**AFFORDABLE ENGINEERING SOFTWARE**
PC/MSDOS—Macintosh—CP/M

**ACNAP — $125.00**
AC Network Analysis Component Libraries, Macros, AUTO Execute

**DCNAP — $95.00**
DC Network Analysis Component Libraries, Macros, AUTO Execute

**SPP — $125.00**
Signal Processing Program Macros, AUTO Execute, Windowing

**PLOTPRO — $72.95**
Scientific Graph Printing

**PCPLOT3 — $95.00**
High Resolution Graphics, Screen and Printer Graphics

**LOCIPRO — $95.00**
Root Locus Analysis Macros, AUTO Execute, Batch

**ACTFIL — $95.00**
Active Filter Design, Analysis, Synthesis

**LCFIL — $95.00**
LC Filter Design/Analysis

**LSP — $95.00**
Logic Circuit Design/Analysis

**RIGHTWRITER — $95.00**
Report Proofreader Program. Applies 2200 Rules of English

**PDP — $95.00**
Scientific Plotting Program for Pen Plotters

**TEKCALC — $95.00**
Programmable Scientific Calculator/Statistics Program

**COMCALC — $72.95**
Communications Budget Calculator and Spreadsheet Program

**XFER — $95.00**
Transfer Function Analysis and Circuit Synthesis

**BV Engineering** Professional Software (714) 781-0252
2200 Business Way, Suite 207, Riverside, CA 92501 U.S.A. TELEX-3089864

CIRCLE NO 337

**LOW-COST UNIVERSAL PROGRAMMER**
From the **World's Largest** supplier of low-cost programming equipment

**FROM $995.00**

Get the FACTs about **E/PROM/PLD/MICRO** programming and **UV ERASER** products from the only company that has managed to supply low-cost quality equipment for years and maintained superb customer support. All products 100% made in U.S. **14 day money back guarantee.**

**LOGICAL DEVICES INC.**
TOLL FREE **1-800-331-7766**
FL (305) 974-0967
1321 NW 65TH PLACE
Ft. Lauderdale, FL 33309
Telex 383142

CIRCLE NO 338

**68000**
*NEW!* **68010**
**Z80 Z80+**
**8085 8088**
**NSC800**
***In-Circuit Emulators***

- Real time or single step execution.
- Small enough to plug into μP socket.
- RS-232 interface to terminal or PC.
- Up/download HEX/S-record files.
- Hardware or software break points.
- *$550 to $1995!*

Nicolet 800-NICOLET (642-6538) or 608-273-5008

CIRCLE NO 339

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

# NEED CIRCUIT PROTECTION?

and other worldwide approvals

**E-T-A has "THE RIGHT STUFF!"**

• Commercial, Mil & Low Cost Types • Magnetic or Thermal • 0.05 to 400 A, 250V AC or 28V DC • ON/OFF Switch/Breaker Combination • PC Board & Snap-in Mounts

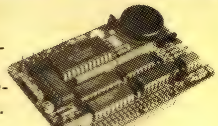
**E-T-A®**
**CIRCUIT BREAKERS**

7400 North Croname Road, Chicago IL 60648 • 312/647-8303

**CIRCLE NO 340**

# MULTIBUS:
## Your Time Has Come!

*The mSBX-241™ Multimodule is a robust, precision Real-Time Clock/Calendar in SBX format with on-board battery backup.*



*General Features:*

- ☐ For high performance systems: no wait states or software overhead
- ☐ Attaches to all SBX and BLX compatible Multibus boards
- ☐ Programmable alarm clock and periodic interrupts
- ☐ 12 or 24 hour time modes, in both BCD and binary format
- ☐ Internal 100 year calendar with leap year compensation
- ☐ Selectable automatic Daylight Savings compensation
- ☐ Contains fifty bytes of general purpose non-volatile RAM
- ☐ **RMX-86/286 drivers supplied on diskette**

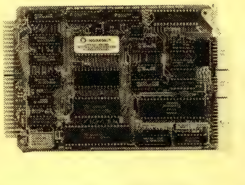
*For more information contact:*

Medinova Corporation
Intelligent Systems Group
244 West Court, Palatine, Illinois 60067
Telephone (312) 934-4700

Multibus, Multimodule TM Intel Corp.

**CIRCLE NO 341**

# DATA ACQUISITION & CONTROL COMPUTER WITH BASIC



The 886 STD Bus CPU is an integrated hardware/software solution for data acquisition and industrial control.

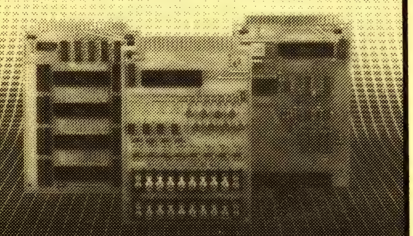
- ROBASIC™-resident, multi-tasking industrial BASIC
- Generates ROMable code
- 9 interrupts supported
- 5 MHz enhanced 8088 CPU
- 1 Mbyte memory addressing
- 160K bytes memory space
- 8 10-bit analog inputs
- RS-232C serial port
- 16 digital channels, 8 high current
- 5 counter/timers
- Autorun capability
- Object code debug monitor
- 5-year warranty

**Call 303-426-8540 for Immediate Response**

OCTAGON SYSTEMS CORPORATION
6510 W. 91st Avenue
Westminster, CO 80030
TELEX: 4931919

**CIRCLE NO 342**

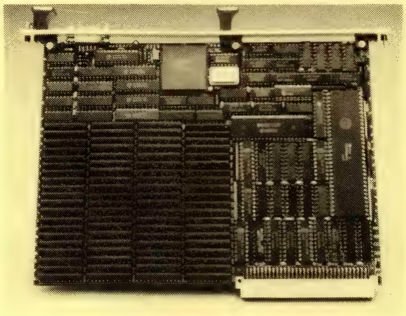
# 6800/6809 Micro Modules



**OEM 6800/6809 MICROCOMPUTER MODULES for dedicated control and monitoring. Interfaces for sensors, transducers, analog signals, solenoids, relays, lamps, pumps, motors, keyboards, displays, IEEE-488, serial I/O, floppy disks.**

WINTEK
Wintek Corp.
1801 South Street
Lafayette, IN 47904
317-742-8428
800-742-6809

**CIRCLE NO 343**



**VME-1280**
**1280 × 1024 × 10 High Resolution Graphic Controller**

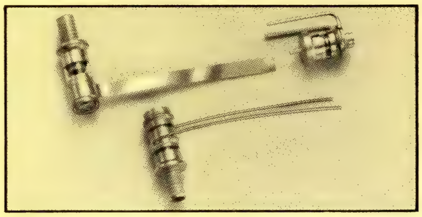
The VME-1280, based on the Hitachi HD-63484 ACRTC VLSI controller chip, is designed for display applications in CAD/CAE workstations, process control, geophysical/seismic work station, and graphic arts.

- Resolution 1280×1024+2
- 8 bits/pixel, 256 colors/shades
- 4096 or 16.8 Million pallette size
- 64 Khz/60 Hz, Non-Interlaced video
- Direct memory mapped access 2.0 million pixels/second

**Imagraph Corporation**
800 West Cummings Pk., Woburn, MA 01801
617-938-5480, Telex: 4946300 IMAGTGI FAX: 617-938-8582

**CIRCLE NO 344**

# HF and VHF

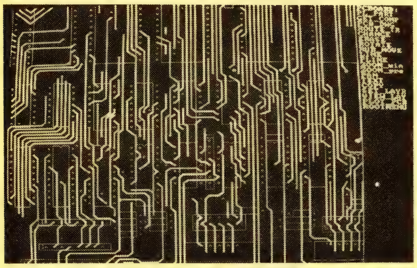


## Sprague-Goodman/JFD Glass Pistoncap® Trimmer Capacitors

The world's largest selection of glass and quartz dielectrics from the industry's leaders since 1951. All feature high Q, great tuning linearity and extreme stability.

**Sprague-Goodman Electronics, Inc.**
SPRAGUE GOODMAN
(An affiliate of the Sprague Electric Company)
134 Fulton Ave., Garden City Park, NY 11040
516-746-1385 • TLX: 14-4533

**CIRCLE NO 345**

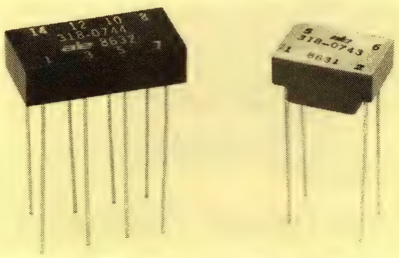


**AUTOROUTER USES ARTIFICIAL INTELLIGENCE TECHNIQUES**

AutoPCB 3.1 is a professional quality, PC-based PCB design system. No co-processor board is required. It features schematic capture, interactive part placement and route editing, and includes AutoROUTE, a powerful autorouter that uses artificial intelligence techniques to identify optimal routing patterns, such as the S turn and C patterns shown above, as part of the routing process. All layers of multilayer boards are routed simultaneously (up to 24). Post processors for photoplotters and drill tapes are available. A large, 4500 component part library lets you start designing boards immediately. A 30-day, full refund guarantee is provided.

**PRO. LIB, Inc.**
624 E. Evelyn Ave., Sunnyvale, CA 94086
Tel. (408) 732-1832, FAX 408-732-4932

**CIRCLE NO 346**



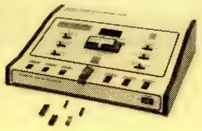
**STARLAN LOCAL AREA NETWORKS BUS COUPLING TRANSFORMERS**

AIE Magnetics introduces new transformers for coupling Manchester encoded data at 1 MHz data rate to a 92 ohm twisted pair bus in conformance to IEEE Standard 802.3 1BASE5. Used for both transmit and receive functions, these transformers provide the DC isolation and high voltage safety required between the bus and the LAN controller or transceiver circuitry.

**AIE Magnetics**
701 Murfreesboro Road
Nashville, Tennessee 37210
615/244-9024

**CIRCLE NO 347**

**THE BETTER RAM TESTER**



**WITH BETTER COST/PERFORMANCE**

**IST Model 6400 ADVANTAGES:**

- Tests most Static RAMs or DRAMs up to 1Mbit.
- Automatically rejects any out-of-tolerance device (in power consumption or speed) by testing operating current and access time.
- A software controlled edge deskew procedure generates the most precise timing waveforms for DRAMs testing.
- Tests function with a group of specialized test patterns to detect all possible faults.
- Interface to automatic IC handlers with front panel control sorting capability.
- Stand alone or slave to a terminal or computer (via RS-232C) for detailed test result display or failure analysis.
- Modular architecture eliminates set-up time when changing over from one device to another.
- Low cost/high performance with one-year warranty. Price: $2,500.

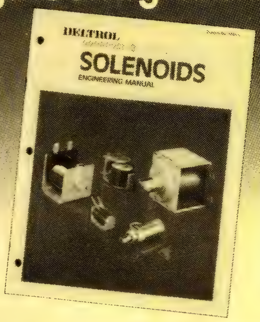
INFORMATION SCAN TECHNOLOGY
IST
487 Gianni Street
Santa Clara, CA 95054
FAX: (408) 980-1794
TELEX: 372 4348 INFO SCAN

**FOR LOW COST/ HIGH PERFORMANCE, call:**
**(408) 988-1908**

**CIRCLE NO 348**

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

# SOLENOID Engineering Manual




Send for the latest 68-page Solenoid Engineering Manual from Deltrol • Packed with useful information including performance data, stroke/force curves, selection factors • Industry's broadest range of miniatures, C frames, D frames, power surge, and tubular solenoids.

**DELTROL controls**
DIVISION OF DELTROL CORP.

2745 S. 19th St.
Milwaukee, WI 53215
Phone 414/671-6800
Telex 2-6871

4305-1

**CIRCLE NO 349**

# PLD PROGRAMMER

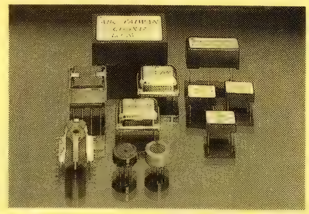
*$1295 Including PC software*

* Supports over 200 PLD's, including bipolar, CMOS, and erasables.
* Universal electronics; software driven from PC/XT/AT or compatible.
* Convenient upgrades on disk; no firmware or personality modules.
* Uses standard JEDEC files; supports 128 test vectors and full screen edit.
* Supported by Nicolet Instruments - over 20 years in high technology.
* Just $1295 complete, including new device updates!

**Nicolet** 800-NICOLET (642-6538) or 608-273-5008.

**CIRCLE NO 350**

# DC-DC CONVERTER PULSE TRANSFORMER FILTER BAND PASS



Our DC-DC converters, pulse transformers & band pass filters is now complete with excellent functions. We also supply choke coils, power chokes, linearity coils, toroidal coils, pulse transformers, coupling transformers, power transformers and others. Send for details today!

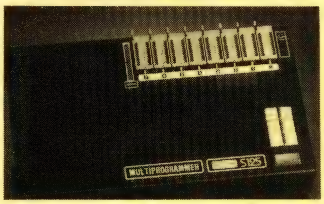
***OEM and Agent Inquiries Invited***

ABC

**ABC TAIWAN ELECTRONICS CORP.**
No. 422, Sec. 1, Yang Fu Rd., Yangmei 32627,
Taoyuan, Taiwan, R.O.C. Fax: (03) 4755503
Tel: (03) 4788088, Telex: 32379 ABCEC

**CIRCLE NO 751**

## GANG/SET EPROM MULTIPROGRAMMMER™ from BYTEK – HIGH PERFORMANCE LEADER




**S125 GANG WRITER** is perfect for the production environment. 32 char. LCD provides user Friendly operation.
**GANG** Programmer: Duplicates up to 8 devices at one time. Optional 16 devices.
**SET** Programmer: Copies up to 4 masters each with different data simultaneously. Optional 8 masters.
Supports all EPROMs & EEPROMs including MegaBit Devices. One Year Warranty. Free Software Updates.
**Just $695.** Compare features and you'll buy **BYTEK**.

**1-800-523-1565**
In FL: (305) 994-3520

**BYTEK CORPORATION**
1021 S. Rogers Cir., Boca Raton, FL 33487
FAX: (305) 994-3615 TELEX: 4998369 BYTEK

**#1 Choice in (E)PROM/PLD MultiProgrammers.**

**CIRCLE NO 752**

## IMPROVE YOUR NETWORK WITH S.I. TECH F/O BIT-DRIVERS

Six fiber optic Bit-Driver products can eliminate many disadvantages of cables, especially: EMI/RFI, ground loops (electrical isolation with fiber), high attenuation (high signal loss), limiting distance between nodes, weight, lightning damage outdoors between buildings. They have been designed to work with:

- Coaxial cable ARCNET – Model 2853
- Single twisted pair cable OMNINET – Model 2852
- Coaxial cable used by IBM in SNA – Model 2870
- Twinax cable used by IBM 34/36/38 systems – Model 2836
- RS-232 or RS-422 Ring networks – Models 2105 or 2106

For a complete catalog of Bit-Driver specification sheets, write:

**S.I. TECH**
P.O. Box 609, Geneva, IL 60134
or call: 312/232-8640

**CIRCLE NO 753**

## Quelo(R) 68000 Software Development Tools

First release 1983 - MOTOROLA compatible - produces ROMable code, S-records, extended TEK hex, UNIX COFF. Portable SOURCE CODE. Native and cross versions on: ATARI ST, AMIGA, Masscomp, Sun, Apollo, Charles River, VAX VMS and UNIX.

**68020 Cross Assembler Package**
Supports 68000, 68010, 68020, 68881 and 68851
For CP/M-68K and MS/PC-DOS - $750

**68000/68010 Cross Assembler Package**
For CP/M-80, -86, -68K and MS/PC-DOS - $595

**68000 "C" Cross Compiler**
For MS/PC-DOS by Lattice, Inc. - $500

NEW ITEMS

**68020 Disassembler**
Supports 68000, 68010, 68020, 68881, 68851
For CP/M-68K and MS/PC-DOS - $495/295.
Amiga and Atari ST - $119/79. CRDS UNOS - $995/595

**68000/68010 Software Simulator**
For MS/PC-DOS by Big Bang Software, Inc. - $285. VAX - $1900

NEW ITEMS

*Call* **Patrick Adams** *today:*
Site, Corporate, OEM licenses
COD, Visa, MasterCard

**Quelo, Inc.**
2464 33rd. West, Suite #173
Seattle, WA USA 98199
Phone 206/285-2528
Telex 910-333-8171

TM: Quelo, Quelo, Inc.; MS, Microsoft Corporation; CP/M, Digital Research

**CIRCLE NO 754**

# SOFTWARE VERSION CONTROL

The **POLYTRON** Version Control System (PVCS) provides precise & flexible configuration management for Software Development projects on Personal Computers and PC LANs, including:

- Storage and retrieval of multiple revisions of source code.
- Maintenance of separate lines of development using branching.
- Merging of simultaneous changes.
- Modules can be reviewed by their own revision number, system version number, or specified date.
- Efficient disk storage. PVCS uses a very intelligent difference detection technique that minimizes the amount of disk space required to store a new version.

**Personal PVCS** — Offers most of the power and flexibility of Corporate PVCS. **$149**

**Corporate PVCS** — Offers features to maintain source code of very large and complex projects that may involve multiple programmers. **$395**

**Network PVCS** — Extends Corporate PVCS for use on Networks. File locking and security levels can be tailored for each project. Call (503) 645-1150 for pricing on Licenses for more than 5 Stations. **$1000**

Requires DOS 2.0 or higher. Compatible with the IBM PC, XT, AT and other MS-DOS PCs. Works with ANY Language.

**TO ORDER:** VISA/MC **1-800-547-4000.**
Dept. No. 322. Oregon and outside US call (503) 645-1150.
Send Checks, P.O.s to: **POLYTRON** Corporation,
1815 NW 169th Place, Suite 2110, Dept 322, Beaverton, OR 97006

**CIRCLE NO 755**


# Glide Through PCB Design.

**TangoPCB**™ Create the toughest board designs with powerful layout software that's a snap to use. Function-rich **Tango-PCB** supports eight layers, 1 mil grid, **OrCAD**™ or **Schema**™ netlist input, print/plot/photoplot output, and more.

**TangoRoute**™ Get impressive completion rates and remarkable speed with **Tango-Route**, a four layer, eleven pass autorouter.

**Just $495 each.**

For IBM PC/XT/AT/PS2. Compare features and you'll buy **Tango**. Or try full-function Demo Package, just $10. Order toll-free: 800 433-7801. VISA/MC. Thirty-day money back guarantee.
ACCEL Technologies, 7358 Trade St., San Diego, CA 92121

**CIRCLE NO 756**

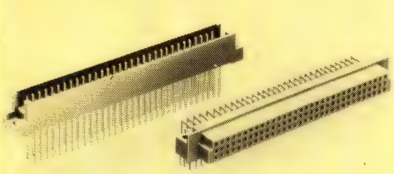

**GP-IB, HP-IB CONTROL FROM YOUR PC.**

- Control instruments and peripherals.
- Supports BASIC, C, FORTRAN, and Pascal.
- Use with ASYST™ Lotus Measure™
- Fast and easy-to-use. Thousands sold.
- Hardware and software - $395 complete.

cec
Capital Equipment Corp.
99 South Bedford St.
Burlington, MA. 01803
Call today (617) 273-1818

**CIRCLE NO 757**

To advertise in Product Mart, call Joanne Dorian, 212/463-6415



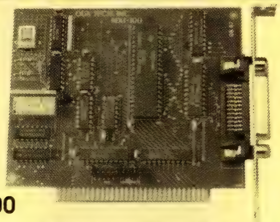
**SAMTEC OFFERS NEW HIGH DENSITY .025" SQ. CONNECTORS**

New HDM and HDF series connectors meet specs for Eurostyle Inverse DIN connectors. Motherboard connectors have phosphor bronze .025" sq. pins, either solder or wrap-pin. Daughterboard has tuning fork style low insertion force contacts of phosphor bronze selectively gold plated over tin. Bodies are glass filled polyester rated UL 94-VO. Both male and female versions mate with competitive connectors of same type. Delivery from stock. Contact:

**Samtec, Inc.,**
P.O. Box 1147, New Albany, IN 47150.
Phone: (812) 944-6733. FAX: (812) 948-5047

**CIRCLE NO 758**

# IEEE-488



MXI-100

- GPIB controller board for IBM PC/XT/AT
- Control up to 14 Devices
- User friendly Software Commands
- DMA Transfer to 200k byte/sec.

$345.00 including software

QUA TECH, INC.
478 E. Exchange St. Akron, OH 44304
(216) 434-3154 TLX: 5101012726

**CIRCLE NO 759**


**16.0 MHz MINIATURE AT QUARTZ CRYSTAL**

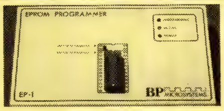
- Surface mountable or with leads
- Mil temp range available
- Shock survival is 3,000gs or more
- Close tolerances
- Applications include mil electronics, telecommunications & frequency control

**THE ONLY NAME YOU NEED TO REMEMBER IN QUARTZ CRYSTALS AND CRYSTAL OSCILLATORS IS STATEK!**

STATEK
STATEK CORPORATION
512 N. Main St., Orange, CA 92668
(714) 639-7810
Made in the U.S.A. - Ship from stock
A Technicorp Company

**CIRCLE NO 760**

**Don't Burn, Shoot, or Blow ... Program with the EP-1 EPRQM PROGRAMMER**



$349

- Free PCDOS software or RS-232 to any computer.
- Reads, Programs, and copies over 250 EPROM's and EEPROM's from AMD, Intel, SEEQ, TI, Fujitsu, Hitachi, Toshiba, and 21 others.
- 2716-27512, 27011, 25XX, 28XX, 87XX, 687XX, Including CMOS and -A suffix.
- Programs 87C51, 8749, 8741A, 8742 and other microcontrollers with optional heads.
- Splits 16- and 32-bit files.
- Generates and checks checksums.
- Batch mode operation works with Make.
- Reads and Generates Intel, Motorola, Tekhex, Straight hex, and binary files.
- 30 day money back guarantee.
- UV Erasers from $34.95.

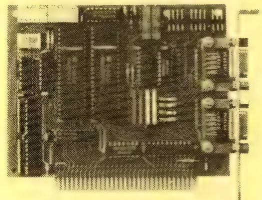
CALL TODAY FOR MORE INFORMATION

BP MICROSYSTEMS
10681 Haddington, #190 / Dept. E1
Houston, Texas 77043
(800) 225-2102 (713) 461-9430 Telex: 1561477

**CIRCLE NO 761**

# RS-422

**Communications Board**

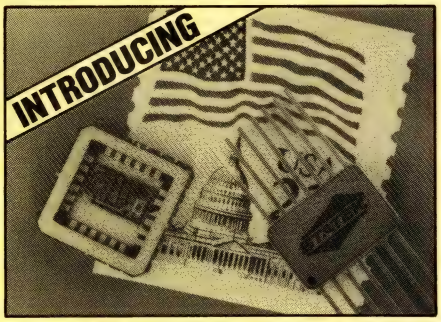


- For IBM-PC/AT/XT and compatibles
- Dual RS-422/RS-485 interface
- Differential drivers to 4000 ft.

*Fast Delivery*

QUA TECH, INC.
478 E. Exchange St. Akron OH 44304
(216) 434-3154 TLX: 5101012726

**CIRCLE NO 762**




**SQXO CRYSTAL OSCILLATOR**

- TO-5 or 24 pin CLCC
- TTL and CMOS compatible hybrid circuit
- Low power version available
- Long term stability, low aging & high shock
- MIL testing available

**THE ONLY NAME YOU NEED TO REMEMBER IN QUARTZ CRYSTALS AND CRYSTAL OSCILLATORS IS STATEK!**

STATEK
STATEK CORPORATION
512 N. Main St., Orange, CA 92668
(714) 639-7810
Made in the U.S.A.
A Technicorp Company

**CIRCLE NO 763**


**EE DESIGNER™**

**CAE/CAD Integrated Software Package for IBM PC, XT or AT**

**$995**

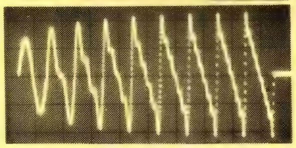
At only $995, no electrical engineer can afford to be without this end-to-end circuit design, simulation and PCB layout tool.
You can pay up to 15 times more and still not get all the features offered by EE Designer—Schematic Capture...Circuit Simulation...PCB Layout.
30 day money back guarantee. Full purchase price refunded if not completely satisfied.

**Call 1-800-553-1177** today to order your package. Bank cards welcome.

VISIONICS
343 Gibraltar Drive
Sunnyvale, CA 94089

**CIRCLE NO 764**

# WAVEFORM SYNTHESIZER

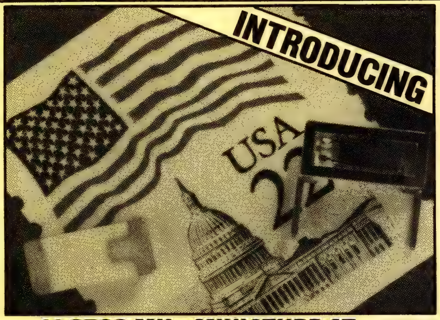


- For IBM-PC/XT/AT and compatibles
- Generates user-definable signal
- Up to 2000 points per envelope

**$795.00**

QUA TECH, INC.
478 E. Exchange St. Akron OH 44304
(216) 434-3154 TLX: 5101012726

**CIRCLE NO 765**




**11.0592 MHz MINIATURE AT QUARTZ CRYSTAL**

- Surface mountable or with leads
- Rugged ceramic packaging
- 1st year aging less than 5ppm
- Low drive current
- Applications include microprocessors, medical, test & POS equipment

**THE ONLY NAME YOU NEED TO REMEMBER IN QUARTZ CRYSTALS AND CRYSTAL OSCILLATORS IS STATEK!**

STATEK
STATEK CORPORATION
512 N. Main St., Orange, CA 92668
(714) 639-7810
Made in the U.S.A. - Ship from stock
A Technicorp Company

**CIRCLE NO 766**

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

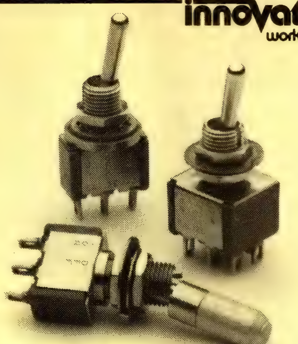

**5W, MINIATURE EFFICIENTLY REGULATED DC/DC CONVERTERS, 500 SERIES**

- ± 10% Input V Accy
- ± 1% Output V Accy
- ± 0.03% Line & Load Reg.
- 200KHz Switch. Freq.
- Pi Input Filter
- Up to 80% Efficiency
- High Power Density
- Short Circuit Protection
- 6-Input V Ranges
- 5-Output V Ranges
- Dual Floating Outputs (Optional)
- Low-Profile 2″ × 1″ × .350″
- From $65 (1-9), Del. Stock –2 wks.

**CONVERSION DEVICES, INC.**
101 Tosca Dr., Stoughton, MA 02072, 617/341-3266

**CIRCLE NO 767**

we make **innovation** work for you



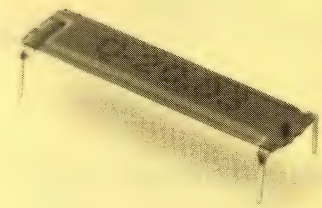
## Cutler-Hammer miniature sealed toggles

**Qualified to MIL-S-83731**

These rugged miniatures are available in 1 and 2-pole configurations, with standard lever or lever lock operation. And they're yours at a miniature price. Technical assistance and customer service are always part of the product. Another innovation from: Eaton Corporation, Aerospace/Commercial Controls Division, 4201 N. 27th St., Milwaukee, WI 53216.

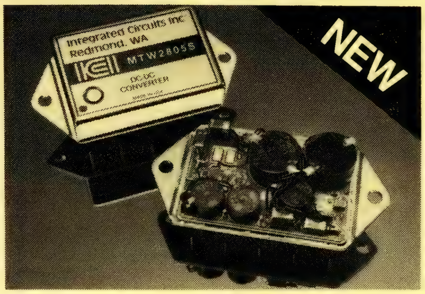
**EATON**

**CIRCLE NO 768**



**SIMPLIFY BOARD LAYOUT**
MICRO/Q ceramic decoupling capacitors share board mounting holes with IC pins to simplify board design. Now add more active devices with increased density in the same space, or design the same package on a smaller board.
**Rogers Corp., 2400 S. Roosevelt St., Tempe, AZ 85282. 602/967-0624**

**CIRCLE NO 769**



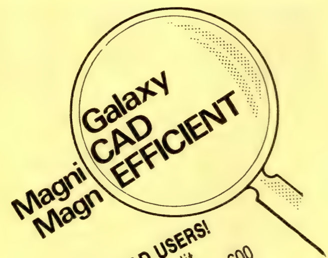

**MTW2805S – MINIATURE DC-DC CONVERTER – 30 WATTS**

Integrated Circuits Inc. announces the MTW2805S, the latest complement to their line of high efficiency, thick film hybrid, DC-DC Converters.

Measuring only 1.95″×1.35″×0.50″ the hermetically sealed MTW2805S generates a fully isolated +5VDC/6amp. output over the input rate of 19-40 VDC from −55°C to +85°C with 82% efficiency (typ.) Other features include short circuit protection, remote load voltage sensing, internal I/O ripple filters, an inhibit function and optional environmental screening $420/100 stock. For additional information, contact:

**INTEGRATED CIRCUITS INCORPORATED**
10301 Willows Road, Redmond, WA 98052
Telephone (206) 882-3100
FAX (206) 882-1990 TWX 910-443-2302

**CIRCLE NO 770**

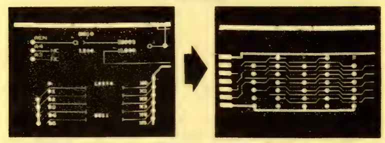



**ATTENTION AUTOCAD USERS!**
Draw faster and instantly edit and regenerate displays in 800 x 600 high-resolution color.
**How? With Galaxy MagniCAD,** the cost-effective PC graphics controller with special magnification windows for speedy AutoCAD drafting.

**GalaGraph Inc.**
1270-E Lawrence Station Rd.
Sunnyvale, CA 94089
Tel. (408)734-2202
Fax. (408)734-2812

**CIRCLE NO 771**

## Schematic to PC Layout $350



**SCHEMATIC CAPTURE $100**

- A through D size drawing.
- 3 levels of zoom
- uses keyboard and or mouse
- User expandable library has over 1000 parts.
- Prints bill of material, net list (Futurenet, EDIF)

**PC BOARD LAYOUT $250**

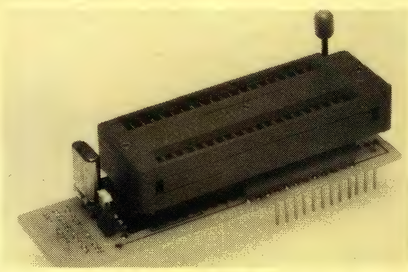
- Board size 36 x 36
- 256 layers include silkscreen & solder mask
- User definable pad and hole shape sizes
- Trace width 001 inch to 0.255 inch
- Connectivity check with NETLIST
- Optional autorouter $ 250 available soon.

Both packages support IBM PC with CGA, EGA & HGA graphics cards IBM, Epson, Okidata printers and Hewlett-Packard, Houston instrument and all other plotters **Demo Disk $ 10**

**(305) 975-9515** **ams** **800-9PC-FREE**

ADVANCED MICROCOMPUTER SYSTEMS, INC
2780 S W 14th Street Pompano Beach, FL 33069

**CIRCLE NO 772**



**$95 8751 PROGRAMMER**

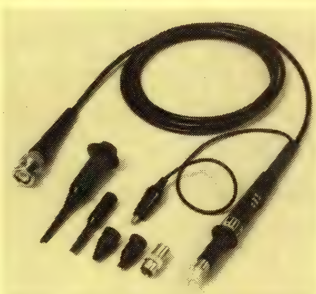
UPA8751 converts any programmer into an 8751 programmer. Production programming of 8751s is fast and cheap with your gang programmer and one or more UPA8751s. Use the UPA8751 to copy protect your code by programming the 8751 security bit.

Price $95 UPS Ground shipping included.

Logical Systems also provides development tools and services. We carry Simulators and Cross-Assemblers. For information call or write:

**Logical Systems**
**6184 Teall Station**
**Syracuse, NY 13217 USA**
**(315) 478-0722 Telex: 6973150 EJB**

**CIRCLE NO 773**



**LOW COST PROBES**

- Replacements for all makes of probes
- Fit all makes of oscilloscopes
- Save up to one-half on cost
- Performance guaranteed
- Send for free catalog
- For immediate service call;
  800-368-5719 outside Calif.
  800-643-8382 in Calif.

**Test Probes, Inc.**
P.O. Box 2113
La Jolla, California 92038

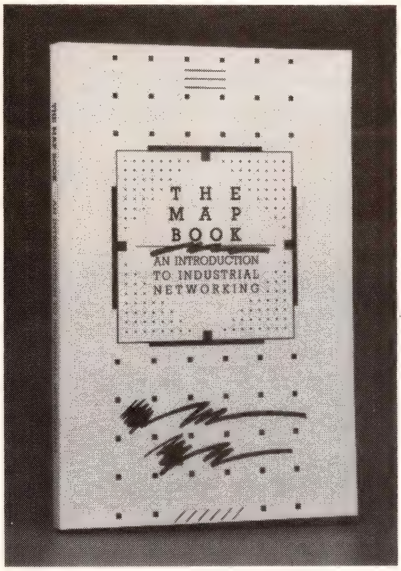
**CIRCLE NO 774**

**smARTWORK® PCB SOFTWARE.** In a fraction of the time hand taping requires, create double-sided printed-circuit boards with smARTWORK and your IBM PC. The program's features include interactive routing, autorouting, continual design-rule checking, automatic pad shaving, a silkscreen, and text for all three layers. **smARTWORK** is $895 and comes with a 30-day money-back guarantee. Credit cards accepted.

**Wintek Corporation**
1801 South Street, Lafayette, IN 47904
(800) 742-6809 or (317) 742-8428

**CIRCLE NO 775**

To advertise in Product Mart, call Joanne Dorian, 212/463-6415




## CIM evaluated

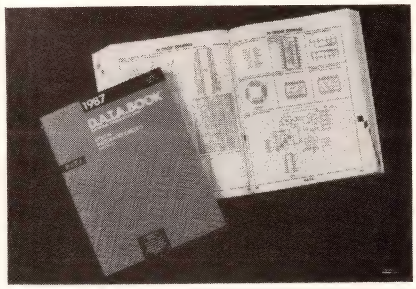
*The MAP Book: An Introduction to Industrial Networking* explains in nontechnical language the basics of the Manufacturing Automation Protocol (MAP) and its role in computer-integrated manufacturing (CIM). The 131-pg book opens with a discussion of current manufacturing trends and goes on to recount a brief history of MAP. It examines the role of factory communications in manufacturing environments, introduces LANs, and describes how to implement a MAP network. $14.95.

**Industrial Networking Inc,** 3990 Freedom Circle, Santa Clara, CA 95052.

**INQUIRE DIRECT**

## Coverage of ICs includes flip-flops and latches

The 22nd edition of *Digital ICs* presents specifications for more than 19,500 digital ICs from 85 manufacturers. New to the publication are the inclusion of flip-flops and latches. More than 1500 devices have been added or updated. Also included are the most recent specs for more than 2300 fixed, tapped, variable, and digitally programmable delay lines, and specifications and logic drawings for recently released ECL and GaAs devices. Other features are circuit/block drawings for each device, as well as outline drawings with dimensions; an enhanced generic index that highlights surface-mount packages; a military/commercial cross-reference section; and manufacturer information. Subscription that includes two semiannual editions, $110.



**DATA Inc,** Box 26875, San Diego, CA 92126.

**INQUIRE DIRECT**

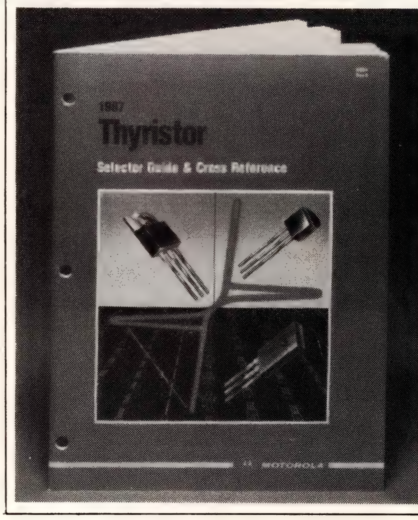
## Catalog describes cables' applications

These two catalogs contain information about tape cable and electronic cables. The 20-pg booklet *Tape Cable: Flat-Flex Cable* is divided into two sections. The standard-products section includes data sheets for the most-used tape-cable products, which come in a variety of conductor widths. The technical-data section contains construction information, including electrical parameters, insulation comparison, flat-wire sizes, and UL styles. *Electronic Cables*, a 44-pg catalog, presents specs for seven types of electronic cable: multiconductor; multipair; coaxial and twinaxial; local-area network; plenum; fiber-optic; and special-application computer.

**Brintec Corp,** Brand-Rex Cable Systems Div, 1600 W Main St, Willimantic, CT 06226.

**Circle No 438**






## Guide summarizes thyristor product line

The fifth edition of the vendor's *Thyristor Selector Guide* includes sections on SCRs, triacs, and trigger devices. The vendor has reduced its thyristor product offering by eliminating odd-value voltage parts and replacing them with the next highest voltage part.

**Motorola Inc,** Literature Distribution Center, Box 20924, Phoenix, AZ 85063.

**Circle No 439**

## Product catalog lists D/A converters

This 144-pg catalog of CMOS A/D converters includes a CMOS data-converter cross-reference guide and specifications for 11 DACs, including a quad 8-bit D/A converter with voltage output, an 8-bit buffered multiplying D/A converter, two 12-bit monolithic multiplying D/A converters, and an 8-bit µP-compatible 12-bit D/A converter.

**Precision Monolithics Inc,** Box 58020, Santa Clara, CA 95052.

**Circle No 440**

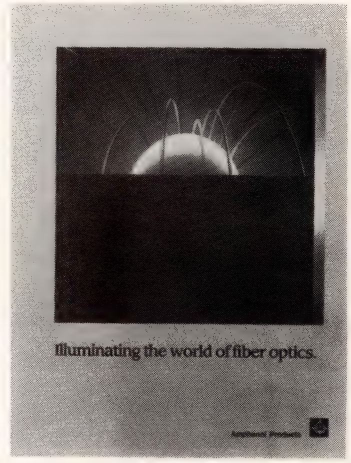
## Booklet categorizes bipolar and CMOS ICs

The 32-pg booklet, *Selection Guides*, offers a long list of bipolar and CMOS ICs. The categories include single, dual, and quad precision operational amplifiers; switching and positive-fixed voltage regulators; low drop-out voltage regulators; positive- and negative-adjustable voltage regulators; and voltage references. Other categories are monolithic switched-capacitor filters; regulating pulse-width modulators; high-frequency and high-current voltage converters; adjustable current sources; and triple, quad, and hex RS-232C drivers and receivers. Specifications and temperature ranges for the military- and commercial-grade versions are listed in tables.

**Linear Technology Corp,** 1630 McCarthy Blvd, Milpitas, CA 95035.

**Circle No 441**






## Guide to fiber optics

*Illuminating the World of Fiber Optics* presents an overview of commercially applicable integrated optics and fiber-optic couplers and connectors. It examines the vendor's use of guided-wave technology to phase modulate light; couplers that have gained advancements in performance, design, and cost; and SMA connectors that feature lower loss and easier termination. The guide also includes information on technical papers, designer's kits, and product literature.

**Amphenol Fiber Optic Products,** 1925 Ohio St, Lisle, IL 60532.

**Circle No 442**

## Catalog details jumpers

This 16-pg 1987 product-information catalog covers preformed jumper wires and bare-wire jumpers on tape and reel. Other products listed are pre-cut hookup wires, kynar wires for wire wrapping, and cut tubing. A small packet of product samples is attached inside the front cover.

**Squires Electronics Inc,** 503 N 13th Ave, Cornelius, OR 97113.

**Circle No 443**

# NEW BOOKS

**Advanced Research in VLSI: Proceedings of the 1987 Stanford Conference,** edited by Paul Losleben. 415 pgs; $40; The MIT Press, Cambridge, MA, 1987. Phone (617) 253-5643.

This book concentrates on basic research involving interdisciplinary work in semiconductor physics, computer science, and electrical engineering that is giving rise to innovative approaches to design, manufacture, and testing. The papers reprinted in this book cover computing architectures, logic and memory, CAD/CAM, system integration, and neural systems.

**Microprocessor Engineering,** by B Holdsworth. 340 pgs; $34.95; Butterworths, Stoneham, MA, 1987. Phone (617) 438-8464.

This book gives an account of the hardware and software techniques employed in microcomputing systems. Concentrating on the Intel 8085A and examining other 8-bit microprocessors as necessary, it offers complete instruction on the design and programming of systems that use these processors as central elements.

**File Structures Using Pascal,** by Nancy E Miller. 487 pgs; $29.95; The Benjamin/Cummings Publishing Co, Menlo Park, CA, 1987. Phone (415) 854-6020.

This book uses Pascal and Pascal-like pseudocode to analyze data structures, such as trees, linked lists, stacks, and queues, for use in file structures. Included are case studies, illustrations, algorithms and exercises, and a glossary of key terms.

**Worst Case Circuit Analysis,** vol 2A. Design and Evaluation Inc, Voorhees, NJ, 1987. Phone (609) 770-0800.

This fourth volume in a series of handbooks expands on RF circuits, including new devices; custom integrated circuits; solid-state switching and drive circuits; and a parts database for extreme value variations of standard $T^2L$ circuits. Numerous examples and case studies are provided. The series contains over 1300 pages of "how to" material for performing worst-case circuit analysis. The basic 3-volume set, $495; volume 2A, $185.

**Operating Systems: A Pragmatic Approach,** 2nd ed, by Harry Katzan, Jr. 449 pgs; $34.95; Van Nostrand Reinhold, New York, NY,

# NEW BOOKS

1986. Phone (212) 254-3232.

This book covers advanced microcomputer operating systems and the latest database technology. A new section on PC-DOS and the mainframe MVS operating system gives hands-on guidance. You learn how to use mainframe virtual storage, virtual input and output, resource management functions, microcomputer tree-structured directories, pipes and filters, and other advanced features.

**Crystal Filters: Design, Manufacture, and Application,** by Robert G Kinsman. 191 pgs; $49.95; John Wiley & Sons, Somerset, NJ, 1987. Phone (201) 469-4400.

This book discusses both monolithic crystal filters and hybrid-lattice filters. It describes these filters, examines their features and limitations, and provides detailed design procedures. The author modifies the basic ladder design to generate the specific crystal-filter designs. The last section offers a variety of application specifications, and covers such topics as selectivity, insertion loss, phase response and group delay, intermodulation distortion, source and load impedance, and drive level.

**The SMT Advance Design Techniques Manual,** by James C Blankenhorn. 250 pgs; $395; SMT Plus Inc, San Jose, CA, 1987. Phone (408) 943-0196.

This manual will assist you in solving the many problems that can occur in the process of designing a very dense and intricate SMT product. It discusses the setup of design rules and explains how to set up your own design rules and implement them in your system. The book examines a variety of design types, including analog, digital, and memory. Also covered are such topics as the problems caused by thermal properties, and the design considerations of photoplotting and of pc-board fabrication.

# EDN's CHARTER

**EDN** is written for professionals in the electronics industry who design, or manage the design of, products ranging from circuits to systems.

**EDN** provides accurate, detailed, and useful information about new technologies, products, and design techniques.

**EDN** covers new and developing technologies to inform its readers of practical design matters that will be of concern to them at once or in the near future.

**EDN** covers new products
- that are immediately or imminently available for purchase
- that have technical data specified in enough detail to permit practical application
- for which accurate price information is available.

**EDN** provides specific "how to" design information that our readers can use immediately. From time to time, EDN's technical editors undertake special "hands-on" projects that demonstrate our commitment to readers' needs for useful information.

**EDN** is written by engineers for engineers.

EDN

275 Washington St
Newton, MA 02158
(617) 964-3030

# BUSINESS/CORPORATE STAFF

**F Warren Dickson**
Vice President/Publisher
Newton, MA 02158
(617) 964-3030
Telex 940573
Diann Siegel, Assistant

**Peter D Coley**
Associate Publisher/
Advertising Sales Director
Newton, MA 02158
(617) 964-3030

**NEW ENGLAND**
John Bartlett, Regional Manager
Chris Platt, Regional Manager
199 Wells Ave
Newton, MA 02159
(617) 964-3730

**STAMFORD 06904**
George Isbell, Regional Manager
8 Stamford Forum, Box 10277
(203) 328-2580

**NEW YORK, NY 10011**
Daniel J Rowland, Regional Manager
249 West 17th St
New York, NY 10011
(212)463-6419

**PHILADELPHIA AREA**
Steve Farkas, Regional Manager
487 Devon Park Dr
Suite 206
Wayne, PA 19087
(215) 293-1212

**CHICAGO AREA**
Clayton Ryder, Regional Manager
Randolph D King, Regional Manager
Cahners Plaza
1350 E Touhy Ave, Box 5080
Des Plaines, IL 60017
(312) 635-8800

**DENVER 80206**
John Huff, Regional Manager
44 Cook St
(303) 388-4511

**DALLAS 75243**
Don Ward, Regional Manager
9330 LBJ Freeway
Suite 1060
(214) 644-3683

**SAN JOSE 95128**
Walt Patstone, Regional Manager
Bill Klanke, Regional Manager
Philip J Branon, Regional Manager
Mark Holdreith, Regional Manager
3031 Tisch Way, Suite 100
(408) 243-8838

**LOS ANGELES 90064**
Charles J Stillman, Jr
Regional Manager
12233 W Olympic Blvd
(213) 826-5818

**ORANGE COUNTY/ SAN DIEGO 92715**
Jim McErlean, Regional Manager
18818 Teller Ave, Suite 170
Irvine, CA
(714) 851-9422

**PORTLAND, OREGON 97221**
Pat Dakin, Regional Manager
Walt Patstone, Regional Manager
1750 SW Skyline Blvd, Box 6
(503) 297-3382

**UNITED KINGDOM/BENELUX**
Jan Dawson, Regional Manager
27 Paul St
London EC2A 4JU UK
44 01-628 7030
Telex: 914911; FAX: 01-628 5984

**SCANDINAVIA**
Stuart Smith
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

**FRANCE/ITALY/SPAIN**
Alasdair Melville
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

**WEST GERMANY/SWITZERLAND/AUSTRIA**
Wolfgang Richter
Sudring 53
7240 Horb/Neckar
West Germany
49-7451-7828; TX: 765450

**ISRAEL**
Igal Elan
Elan Marketing Group
13 Haifa St, Box 33439
Tel-Aviv, Israel
Tel: 972-3-268020
TX: 341667

**EASTERN BLOC**
Uwe Kretzschmar
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

**FAR EAST**
Ed Schrader, General Manager
18818 Teller Ave, Suite 170
Irvine, CA 92715
(714) 851-9422; Telex: 183653

**TOKYO 160**
Kaoru Hara
Dynaco International Inc
Suite 1003, Sun-Palace Shinjuku
8-12-1 Nishishinjuku, Shinjuku-ku
Tokyo 160, Japan
Tel: (03) 366-8301
Telex: J2322609 DYNACO

**TAIWAN**
Acteam International
Marketing Corp
6F, No 43, Lane 13
Kwang Fu South Rd
Mailing Box 18-91
Taipei, Taiwan ROC
760-6209 or 760-6210
Telex: 29809
FAX: (02) 7604784

**KOREA**
Korea Media Inc
Rm 110, A-11 Bldg 49-4,
Hoihyundong 2-Ka, Chung-Ku
CPO Box 2314, Seoul, Korea
Tel: 82-2-755-9880
Telex: K26249

**SINGAPORE**
Cheny Tan Associates
1 Goldhill Plaza
No 02-01
Newton Rd
Singapore 1130
Tel: 2549522
Telex: RS 35983 CTAL

**PRODUCT MART**
Joanne Dorian, Manager
249 West 17th St
New York, NY 10011
(212) 463-6415

**CAREER OPPORTUNITIES/ CAREER NEWS**
Roberta Renard
National Sales Manager
103 Eisenhower Parkway
Roseland, NJ 07068
(201) 228-8602

Janet O Penn
Eastern Sales Manager
103 Eisenhower Parkway
Roseland, NJ 07068
(201) 228-8610

Dan Brink
Western Sales Manager
18818 Teller Ave
Suite 170
Irvine, CA 92715
(714) 851-9422

Diann Siegel
Boston Sales Representative
Newton, MA 02158
(617) 964-3030

Maria Cubas
Production Assistant
(201) 228-8608

**Cahners Magazine Division**
William Platt, President
Terry McDermott, Executive Vice President
Frank Sibley, Group Vice President
Tom Dellamaria, VP/Production & Manufacturing

**Circulation**
Denver, CO: (303) 388-4511
Sherri Gronli, Group Manager
Eric Schmierer, Manager

**Reprints of EDN articles are available on a custom printing basis at reasonable prices in quantities of 500 or more. For an exact quote, contact Joanne R Westphal, Cahners Reprint Service, Cahners Plaza, 1350 E Touhy Ave, Box 5080, Des Plaines, IL 60018. Phone (312) 635-8800.**

Deborah Asbrand, *Associate Editor*

## LAUREN CHRISTOPHER

# Zooming in on digital ICs for television

Eugene Mopsik

Although she credits good luck with many of her successes, Lauren Christopher clearly knows how to make things happen. Since graduating from MIT in 1982, she's earned three patent awards, become the manager of a research group developing digital ICs for television, served as technical advisor to the 1987 Custom Integrated Circuits Conference, and designed two digital signal processing chips that reached the market in May of this year. Her life outside of engineering has been no less active: She's flown solo in a Piper Cub, gone scuba diving in Hawaii, skied the Swiss Alps, and traveled to Denmark, Spain, France, and Japan. And in 1985 she got married.

Christopher has been single-minded about her career in IC design since a high-school physics teacher briefly covered the subject of semiconductor physics. Now she is determined to push IC technology in new directions. Her group is designing digital signal processing ICs with the hopes of taking sophisticated techniques used in film, such as zoom, pan, and freeze-frame, and making them standard television features. What's more, they must keep the new technology affordable

**Most companies "weren't doing much in signal processing. They wanted an IC designer to go out and do yet another computer chip."**

enough to attract the attention of the nation's 87 million television-owning households.

An employee of the David Sarnoff Research Center in Princeton, NJ, Christopher has begun to catch the interest of the engineering community at large. The *New York Times* featured as the lead story in its Saturday patent section the window-scanned memory she designed for CRT memory management at the pixel level. And last April, Eta Kappa Nu, the electrical engineering honor society, awarded Christopher honorable mention as its outstanding young electrical engineer. Earlier winners of the award have included such electronics luminaries as Kenneth Olsen and Simon Ramo.

From the time Christopher arrived in Cambridge, MA, as an MIT freshman, she steadfastly pursued IC design. Shortly after the first semester began, she remembers, she scoured the undergraduate course book, writing down the names of any courses on semiconductor technology. MIT accepted her into its co-op program, which allows students to earn bachelor's and master's degrees in five years. The co-op program also requires its students to spend two summers and one semester working in industry. Noting Christopher's nascent interest in integrated circuits and signal processing, MIT assigned her to work as a co-op student at RCA's Sarnoff Center, a 350-acre facility known for its pioneering work in color television.


Eugene Mopsik

The match turned out to be an excellent one. The Sarnoff Center was doing research on digital filters, and Christopher got the opportunity to design and lay out a programmable finite impulse response (FIR) digital filter that later became her thesis project. The chip is a basic building block for signal processing. It can be used for any operation in the signal-processing path that needs to separate two signals or attenuate certain frequencies. A copy of that CMOS chip, preserved in acrylic, now sits on her desk. Completing her first chip gave her "a real sense of accomplishment and creativity," she says. "It's fun when you finally get to give it a try."

After graduating from MIT in 1982, Christopher wanted a job that would give her an opportunity to combine her interests in IC design and signal processing. Most companies, she says, "weren't doing much in signal processing. They wanted an IC designer to go out and do yet another computer chip."

Despite RCA's reputation at that time as a technically slumbering company, Christopher accepted a full-time position with the Sarnoff Center's consumer-electronics IC-research group. Although television technology has used digital tuning systems since 1975, the signal processing itself—the path that comes from the antenna through to the electron guns—remains analog. The IC group was researching techniques that would convert the analog functions to digital ones and consequently produce better quality televisions at a lower cost.

Television had long intrigued Christopher. "It was always inter-

**"A lot of people look at IC design as taking a system idea, turning the crank, and out pops the IC. The best way is to work with the system designer from the inception."**

esting to me," she says. "I remember as a kid opening up the back and looking at the tubes." Researching the application of DSP ICs for television also appealed to her because of TV's omnipresence in American homes. "Television is important as a visual medium, and up until now it hasn't been exploited [technologically] all that well."

Christopher's ability to contribute to the research group was apparent very early on, says Dalton Pritchard, an RCA fellow who recently retired after 40 years with the company. "My job was to bring new people up to speed in television systems," Pritchard says. "She attended one of my lectures, and her ability to follow fundamental principles and then understand how her knowledge of IC design could be applied was outstanding."

Christopher worked on several research projects and also spent six months at NV Philips' facility in Hamburg, West Germany, working on a joint project between RCA and the giant Dutch electronics company. In September of 1985, RCA chose her as one of 10 lab engineers to enter a management-training program. Her first assignment was to manage a small project on standard DSP chips at the company's Solid State Division in Somerville, NJ.

Six months later, the research lab in Princeton asked Christopher to return to the consumer-electronics IC group she had started with. Only this time, they wanted her to head the consumer-electronics group. "It was a hard decision because I felt loyalty to both groups. I wanted to see the digital products get out. But this was a great opportunity." In the end, she decided to return to her old group.

It didn't take long, however, for the downside of managerial responsibilities to become apparent. Shortly before she began her new job, in December of 1986, RCA announced its merger with General Electric. "I heard the news on my way to work," Christopher remembers. "RCA was a company I never thought would be bought out." When she took over as group head the following March, a climate of insecurity pervaded the laboratory.

Then earlier this year, General Electric donated the Sarnoff facility to SRI International, a nonprofit research and consulting company. One of SRI's first acts was to cut 200 Sarnoff Center workers from the payroll; Christopher was told to lay off two longstanding members of her group. To complicate matters, a key member of the group announced his retirement. Christopher felt that through his leaving, the team had lost some of its cohesiveness. "It was very hard," she remembers. "But we had to move ahead."

General Electric's brief administration, though, did create a new challenge for the Sarnoff Center's technical staff because it opened the center's doors to contract bidding. "It's become more exciting," Christopher says. "We're opening up to the world. Before, we were a closed community."

As manager of the group, she does less designing than she used to, spending much of her time consulting with group members on the various ongoing projects. She considers it critical that IC designers establish a cooperative relationship with systems designers early in a project. "A lot of people look at IC design as taking a system idea, turning the crank, and out pops the IC," she says. "The best way is to work with the system designer from the inception. When I talk with people about new projects, I always advise that the designer be in on it early."

To compensate for the lack of hands-on experience, Christoper keeps up-to-date by reading mounds of technical journals. She's also a technical advisor to the Custom Integrated Circuits Conference, an advantageous position she obtained largely by happenstance: When her supervisor couldn't attend an advisory meeting, he asked Christopher to substitute for him. Pleased with her contributions, the committee asked her to stay on as a member. She considers her committee participation—which requires her to read all papers submitted for presentation—an important part of her efforts to stay current on design techniques.

Still, she worries that, without hands-on experience, even her most active efforts to follow technology may not be enough. "CAD is changing a lot, and I wonder whether I'll stay up-to-date on it as I become more administrative and have less time to keep up."

She remains matter-of-fact about her new responsibilities. "The management thing was sort of a whim. I had originally said that yes, I'd be interested in management eventually, but I had no idea it would come so fast." She now sees management as a positive next step for her. "When I got into the management training program, I discovered that I liked thinking about direction and helping people."

Meanwhile, she and her group expect that the newly competitive atmosphere in which they work may speed the development of digital-IC television. "We're nearing the age of high-definition TV, and DSP will be a large part of it," she says. **EDN**

---

**Article Interest Quotient**
**(Circle One)**
**High 518 Medium 519 Low 520**

# CAREER OPPORTUNITIES

## 1987 Editorial Calendar and Planning Guide

**EDN**

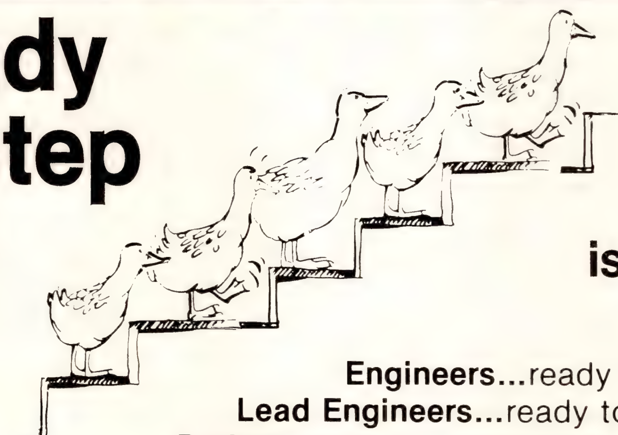
| Issue Date | Recruitment Deadline | Editorial Emphasis | EDN News |
|---|---|---|---|
| Oct. 1 | Sept. 10 | Surface-Mount Technology; Computers & Peripherals; Industrial Product Showcase | |
| Oct. 15 | Sept. 24 | Test & Measurement Special Issue; Analog ICs; ASICs | Closing: Sept. 17<br>Mailing: Oct. 8 |
| Oct. 29 | Oct. 8 | Computers & Peripherals; ICs & Semiconductors; Wescon '87 Product Preview | |
| Nov. 12 | Oct. 22 | Wescon '87 Show Issue; ICs; Computers & Peripherals | Closing: Oct. 15<br>Mailing: Nov. 5 |
| Nov. 26 | Nov. 5 | Microprocessor Technology Report & Directory; Analog ICs; Sensors & Transducers | |
| Dec. 10 | Nov. 19 | Product Showcase-Volume I; ICs and Semiconductors; Software | Closing: Nov. 12<br>Mailing: Dec. 3 |
| Dec. 24 | Dec. 3 | Product Showcase-Volume II; Computers & Peripherals; Test & Measurement Instruments | |

**Call today for information.**

East Coast Janet O. Penn (201) 228-8610
West Coast Dan Brink (714) 851-9422
National Roberta Renard (201) 228-8602

---

# Ready to step up?



## But the next step is already occupied?

### We want to talk to...

**Engineers**...ready to be...**LEAD ENGINEERS**
**Lead Engineers**...ready to be...**PROJECT LEADERS**
**Project Leaders**...ready to be...**PROGRAM MANAGERS**
**Program Managers**...ready to be...**DEPARTMENT MANAGERS**

*Join EG&G's fast growing, high tech Engineering team in Las Vegas. We can offer you both technical challenges and career growth opportunities in Systems Analysis, Design, Development & Test of unique Electronic Systems for DOD...RF Measurement, Avionics, Radar, Communications and EW.*

Enjoy great climate, light traffic, good schools, affordable housing, no state income tax...

**EG&G**

An Equal Opportunity Employer
U.S. Citizenship Required

**EG&G Special Projects, Inc. • Dept. EDN 8-7 • P.O. Box 93747 • Las Vegas, Nevada 89193-3747**
**(702) 369-3000 • Ask for Jack Pollock, Recruiter**

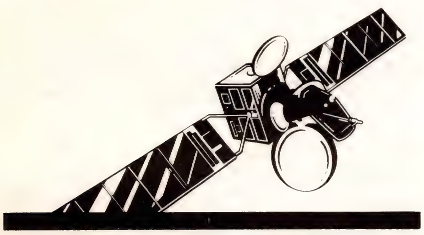

47

Western Development Laboratories Division

# We're the hottest company in the business!

Western Development Laboratories Division has dozens of contracts underway, many in multi-year programs, with a backlog stretching well into the 1990s. Our success is due to many factors — technological innovation, a reputation for quality and reliability, and a diverse set of capabilities, from software development to spacecraft construction.

You can find out more by applying for one of the following current openings:



## Engineering Designer

Assignments include layout design of mechanical and structural components of large antennas and associated microwave feeds. Requires 6-8 years' experience in the design of military electronic racks and chassis along with hands-on experience on either 2D or 3D systems. **Respond to Dept. RP-EDN0820.**

## Antenna Engineers

Conceptual and final design of antenna systems and components, particularly array microwave and printed circuit patch radiator design techniques. Requires 8 years' related experience, including subproject management and Fortran IV, with an MS or PhD in EE/Microwave. **Respond to Dept. RP-EDN0820.**

## Software Engineers

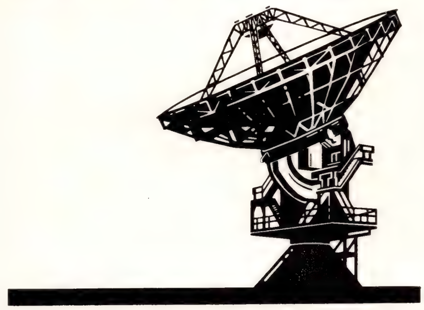
Work with a large VAX/VMS-based network using workstations, supporting graphics, data base, mission management, situation assessment, and reporting functions. The system will support real-time sensor packages processing live data. Openings are in various areas, requiring from 2-15 years' experience, knowledge of VAX/VMS and structure techniques. Areas include:

- DBMS-algorithm development, top-level design, structured analysis for DB front end.
- Mission Management-LOS computations, terrain masking, and optimal track assignment.
- VMS Internals-write device drivers, perform SYSGENs, configure and fine-tune the OS, support others in system design. IAS experience preferred.
- Situation Assessment-assess and perform situation correlation in a tactical environment.
- Image Exploitation-design to manipulate imagery, graphics and alphanumeric data for image exploitation and report generation.

**Respond to Dept. PF-EDN0820.**

## Communications Equipment Engineer

Define subsystem architecture, develop subassembly/assembly-level interface specs and TEMPEST design criteria, direct equipment circuit design and equipment procurement. Requires 10 years' related experience in military data, voice, and fiber optic communications systems. BSEE or equivalent. Experience with state-of-the-art technical control facility design a priority. **Respond to Dept. JP-EDN0820.**



## MIC Process Engineer

Be part of the development and sustaining function in the area of hybrid and substrate fabrication. Must have direct experience in die attach, wire bonding, sealing or MICs. A BS in an engineering science or equivalent and 3+ years of experience with substrate fabrication processes are essential. **Respond to Dept. JP-EDN0820.**

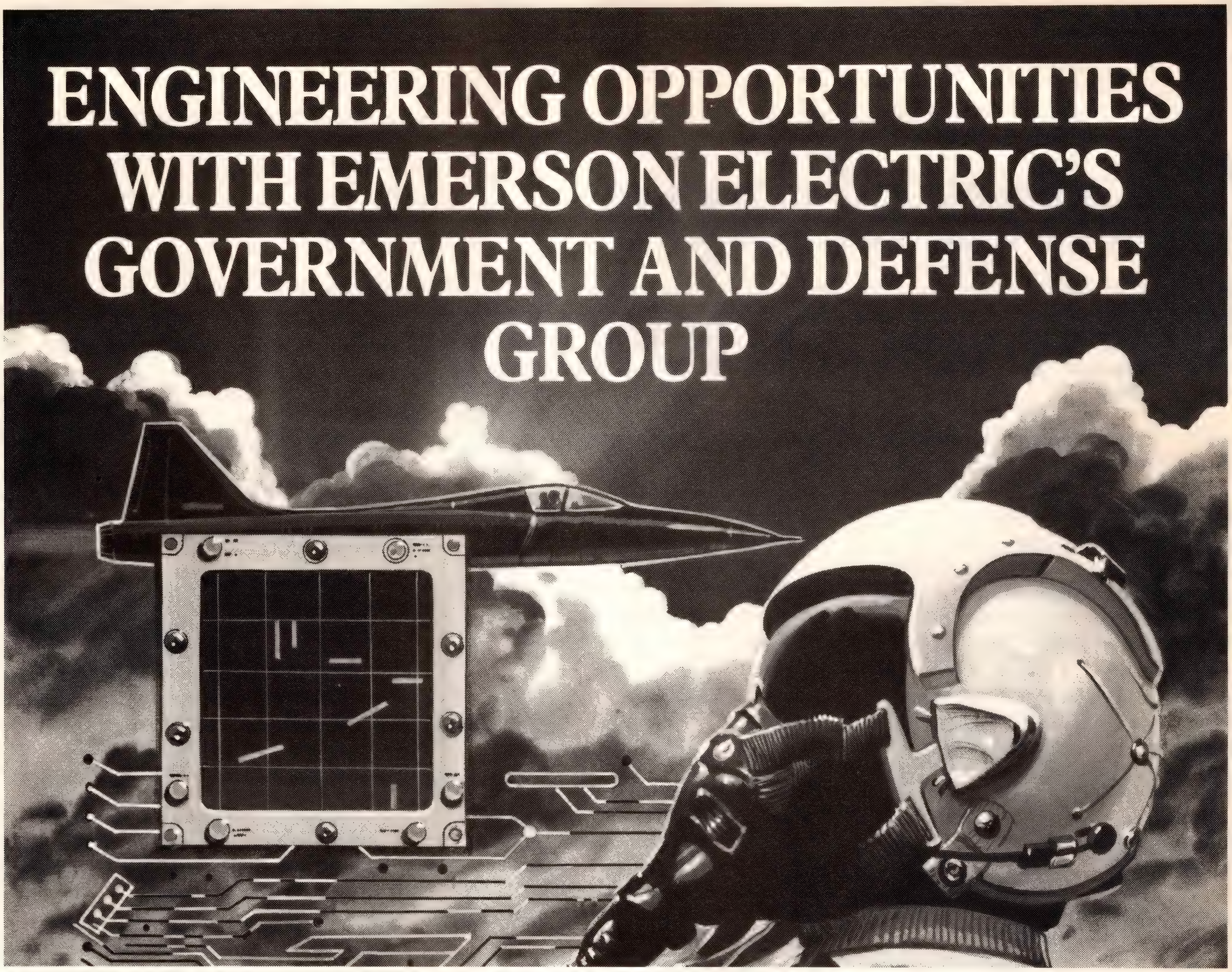
Send your resume, indicating appropriate department, to Ford Aerospace & Communications Corporation, Western Development Laboratories Division, Professional Staffing, 3939 Fabian Way, M/S D04, Palo Alto, CA 94303-4697. An equal opportunity employer. Principals only, please.

Ford

**Ford Aerospace & Communications Corporation**

Western Development Laboratories Division

U.S. Citizenship May Be Required.




- **SOFTWARE DESIGN ENGINEERS**
- **SYSTEMS PROGRAMMER**
- **RELIABILITY/MAINTAINABILITY ENGINEERS**
- **RADAR SYSTEMS ENGINEERS (ON-GOING PROJECTS)**

We are looking for a select group of professionals to work on major government and defense contracts awarded to Emerson Electric. Diverse projects are available for individuals who meet our professional and educational standards. All disciplines listed will work out of our facility in St. Louis. Candidates considered qualified must have a BSEE, BSEET, BSCS degree or higher as specified.

**SOFTWARE DESIGN ENGINEERS**
Real-time signal processing software development experience in 6809, 68000, and 68020 microprocessors. Additional positions require experience in the design and development of Test Systems software and application of systems. All positions require experience in one or more of the following systems or languages: VAX/VMS, 1750A, FORTRAN, C, Ada, JOVIAL, FORTH, Assembly languages, and ATLAS.

**SYSTEMS PROGRAMMER**
Responsibilities will include monitoring, developing and controlling the system software on DEC-20, VAX. Also responsible for the operation of the system and an Interconnecting Ethernet Local Area Network. Minimum of 3 years experience in progressive software and hardware, with recent experience in computer operating systems. BSCS/BSEE required.

**RELIABILITY/MAINTAINABILITY ENGINEERS**
Perform reliability and maintainability related analysis of electronic and mechanical systems. Prepare proposal and program plan inputs. Interface with design, components, failure analysis, logistics, and test engineering personnel. Requires minimum of 3 to 10 years electronic circuit analysis and preparation of reliability related analysis. Must be familiar with reliability and maintainability MIL-Specs and program requirements.

**RADAR SYSTEMS ENGINEERS (ON-GOING PROJECTS)**
Provide system analysis, performance tracking, integration, and test of airborne and ground based radar systems. Interface with customer and provide flight test support of installed radar system. Minimum of 10 years or more experience in radar systems is required. Specific experience in the areas of coherent airborne radar TF/TA, or millimeter wave radar is highly desired. Minimum BSEE Physics or Math background required and MSEE desired.

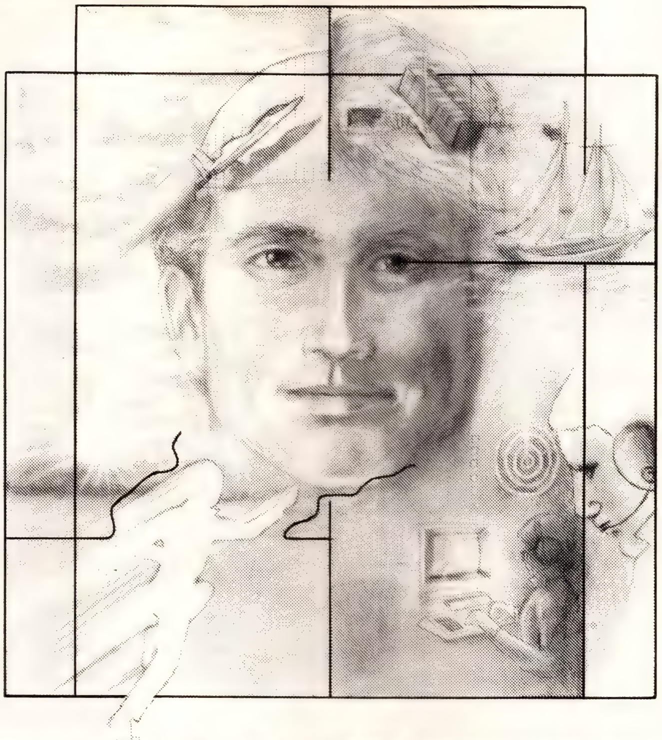
For prompt consideration, send your confidential resume to:

Al Kaste
Mail Station 4335 — Dept. EDN
Electronics and Space Division
8100 W. Florissant Avenue
St. Louis, MO 63136

An equal opportunity employer. U.S. citizenship is required.

**EMERSON ELECTRIC CO.**
**Government & Defense Group**

# Technical Excellence



# Our Greatest Achievement Unlocks Your Greatest Potential.

For over 60 years, Raytheon has been recognized as an authoritative source of technological innovation and excellence. Today, our Missile Systems Division continues the tradition of excellence with technical involvement deep enough to create advanced, workable, comprehensive engineering solutions; broad enough to encompass practically every discipline in electronics research, design, development, and production; and high enough to provide each of our talented technical professionals to determine tomorrow's state-of-the-art.

That's why the Missile Systems Division of Fortune-50 Raytheon is the ideal environment to develop your potential to its fullest and discover the important contribution you can make to the technology of your choice for some of the world's most important air defense systems.

Located in the center of technological innovation and excellence of the Route 128 area and only minutes from the unmatched educational, cultural, and recreational resources of Boston, Raytheon's Missile Systems Division also offers access to the exceptional quality of life of Massachusetts and the entire New England Region.

Raytheon: technical diversity and excellence that first unlocks potential . . . and then opens an extraordinary number of doors to success.

**Current opportunities exist for qualified engineers in the following applications:**
**☐ RF/Microwave Systems Design ☐ Digital Systems Design ☐ Real-Time Software Systems Design ☐ Guidance and Control Design ☐ Test Systems Design ☐ Radar Systems ☐ Reliability/Quality Assurance ☐ Electro-Optics Design ☐ Missile Guidance Design**

Engineering positions require a minimum BS degree in Electrical or Computer Engineering, Physics or Mathematics and at least 3–5 years' experience with real-time command and control systems, radars, missile guidance and digital equipment.

Raytheon offers excellent salaries and many company-paid benefits as well as Investment Plans and liberal relocation assistance. Please send resume with salary requirements to:
**Manager, Professional Employment, Dept. E, Raytheon Company, Missile Systems Division, Hartwell Rd., Bedford, MA 01730. U.S. Citizenship required. An Equal Opportunity Employer.**

**Raytheon**

*Where quality starts with fundamentals.*

# Engineers:

## Pan Am World Services, Inc. provides exactly the range that brilliant careers require.

### One range is geographical

World Services is prime contractor to the U.S. Air Force for the planning, engineering and operation of the Eastern Test Range. It stretches 10,000 miles from Cape Canaveral to Pretoria, South Africa, and includes some 1,800 ship and land based tracking units.

### Another is professional

We have long been involved with the entire space program. Missiles. Satellites. Space Shuttle. You name it. Depending on orientation, you'll be seeing, and contributing to, the last word in radar, optical instrumentation, telemetry, communications, data handling, $C^2$, statistical data reduction, meteorology, timing/firing, frequency control, shipboard instrumentation . . . and related technologies.

### The third range is choice

Following is a diverse array of engineering opportunities. Each requires a BSEE degree and at least 5 years relevant experience.

**TELEMETRY SYSTEMS ENGINEER**
Will accomplish design, acquisition, installation and evaluation of antennas, preamplifiers, mixers, down-converters, filters, demodulators, decommutators and computer interfaces for large aperture S-band telemetry antenna systems. Must perform hardware design and system analysis.

**DATA SYSTEMS ENGINEER**
Will accomplish design, acquisition, installation and evaluation of data acquisition, transmission, processing and display systems for distributed instrumentation complexes. Must have substantial experience in system/subsystem design, test and evaluation.

**RADAR SYSTEMS ENGINEER**
Will perform design, acquisition, installation and evaluation of high power transmitters, solid-state receivers, and digital range machines, and preparation of specifications for new land and shipboard radar used in tracking and signature data collection. Must be experienced in system/subsystem design, test and evaluation.

**OPTICAL SYSTEMS ENGINEER**
Will perform system design, installation, modification and evaluation of manned and unmanned optical tracker and camera systems.

**COMMUNICATIONS SYSTEMS ENGINEER**
Will accomplish design, acquisition, installation and evaluation of subsystem equipment and systems to support communications and timing requirements. ETR Communications Systems include analog and digital communications systems, red and black switching systems, long and short haul data transmission over HF, Microwave, Satellite and Cable (copper and fiber optics) Systems and Electronic Security Systems. Timing includes state-of-the-art PTTI systems.

### Other attractions

Florida at its best...specifically, the Cocoa Beach area, excellent salaries, extensive benefits, stimulating associates, excellent career prospects, and eligibility for 75% discount travel on Pan Am for yourself and each eligible family member. Learn more. Contact Don Mosby at (305) 494-7322, or send your resume indicating position of interest to him at Pan Am World Services, Inc., Ref. 87-103, P.O. Box 4608, Building 423, MU 100, Patrick Air Force Base, Florida 32925.

**Pan Am World Services, Inc.**

An Equal Opportunity Employer • U.S. Citizenship Required

# Engineers & Scientists


*Current Opportunities In*

## INERTIAL INSTRUMENTS & RADAR/COMMUNICATIONS

### DESIGN & DEVELOPMENT BS/MSEE

- Inertial Instrument Design Gyros-Accelerometers
- Inertial Navigation Systems Analyses
- Optimal Filtering Techniques
- Automatic Control Theory
- Closed Loop Control Techniques
- Microwave—RF
- Antennas
- Radar
- HW/SW Systems

### PRODUCT ASSURANCE BS, BT

- Establish Test Equipment Requirements
- Reliability
- System Level Testing
- Inertial Instrument Fabrication & Test
- Hardware/Software Quality
- Develop QA criteria for electro-mechanical components & systems
- Process Control

Some people think only "snow" when they think Buffalo. We do get snow, and enjoy great skiing.

But in fact, Buffalo has more sunny days than other parts of the state. We average only 3 days/year when the mercury hits zero. We get less precipitation than Miami or Mobile. We enjoy a full 4-season lifestyle.

You see, a lot more than snow is coming down in Buffalo. The excitement of our professional sports teams. Theatres. Art. The Buffalo Philharmonic. More than 1000 lively restaurants and clubs. 3000 acres of parks with sailing, swimming, tennis, golf—all kinds of family recreation.

And Buffalo's easy living is easily affordable. Good-sized houses, for example, cost less than half what they would in most other cities. What's more—commuting to and from Buffalo is a breeze. Transportation facilities are excellent.

**A MAJOR BUFFALO ATTRACTION: BELL AEROSPACE TEXTRON.
WHERE YOUR CAREER FORGES AHEAD ON THE LEADING EDGE OF TECHNOLOGY.**

Engineers with a keen eye to the future think "Bell" when they think Buffalo. Bell appeals to your zest for breakthrough technology in gravity measuring systems • inertial instruments like accelerometers and gyros • velocity meters • cooled instruments/cool laser mirrors • antenna systems—airborne, shipboard and land vehicle • automatic aircraft and microwave landing systems and more.

Brilliant "firsts" are a 50-year tradition with Bell. With management strongly committed to initiative, we back you with the last word in design and test system resources.

Whatever your current discipline and experience, forge ahead by sending your resume with salary history to: **David W. Pearl, Bell Aerospace Textron, P.O. Box One, Buffalo, NY 14240. Discover all the features that make Buffalo and Bell a great home base.**

***Technology... Bell's response to an ever-changing world.***

**Bell Aerospace TEXTRON**

Division of Textron Inc.

# E-SYSTEMS

## E-SYSTEMS, INC., ECI DIVISION ST. PETERSBURG, FLORIDA

At E-Systems, we're pushing back the parameters of present-day technology. Our state-of-the-art career opportunities allow visions to be molded into realities. This, combined with the pleasant Florida climate makes E-Systems ECI Division a dynamic place for the experienced technical professional.

If you are qualified and would like a career of accomplishment and satisfaction, ECI Division has immediate opportunities in these areas of design and development of military communications systems:

### Systems/Software Design
- **Communications Systems Engineer**
- **Computer Systems Architect**
- **Systems Integration & Test Engineer**
- **Software Engineer**
- **Software Quality Assurance Engineer**

### Technical Support
- **Configuration Management Specialist**
- **Senior Mechanical Designer**
- **Data Management Specialist**
- **Senior Software Technical Writer**
- **Proposal Writer/Editor**

### Manufacturing Engineering
- **Industrial Engineer**
- **Manufacturing Engineer**
- **Production Test Engineer**

### Engineering Quality
- **EMI/TEMPEST Engineer**
- **Maintainability/ILS Engineer**
- **Component Engineer**

### Hardware Design
- **Digital Circuit Engineer**
- **Transmitter/Receiver RF Engineer**
- **Modem Design Engineer**
- **Senior Mechanical Engineer**
- **Senior Digital Engineer**

In addition to the chance to make meaningful contributions, you will find E-Systems offers one of the best employee stock, ownership and relocation programs available.

If you are attracted to a dynamic work environment and have the solid experience required for one of the above opportunities, respond immediately by sending your resume to: **Director of Employee Relations, E-Systems, Inc., ECI Division, Post Office Box 12248, St. Petersburg, Florida 33733.**

**E-SYSTEMS**

The science of systems.

Principals Only, Please.
U.S. Citizenship Required.
An Equal Opportunity Employer, M/F, V, H.

# "This is a state-of-the-art company

working on R&D contracts
within almost every field of electronics technology."

Rickie Currens
*Engineering Manager, Strategic Secure Communications Office*

*The professionals of Motorola's **Government Electronics Group** (GEG) have much to say about their company because GEG is a place where innovative ideas are put into action. The result is leadership in the research, development and manufacture of electronic hardware for our country's defense, national security and space programs. If you have the imagination and skill required to extend our technical frontiers, consider the opportunities now available.*

## ENGINEERING

### Software QA Engineers

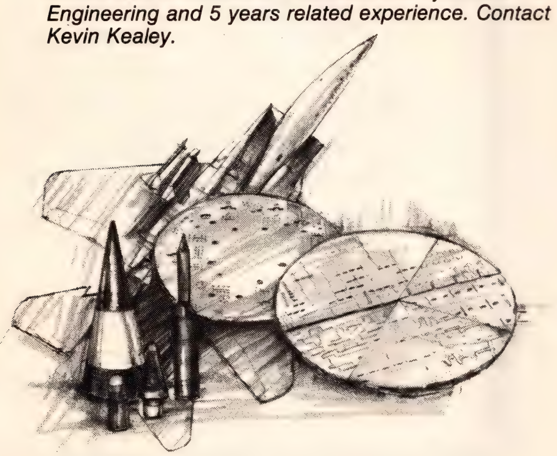
*Define and implement S/W QA Programs. Requires knowledge of engineering and QA procedures, as well as related government regulations (MIL-STD-2167, MIL-S-52779A, NSAM 81-2, NSAM 81-3, MIL-Q-9858, etc.). Familiarity with C, FORTRAN, Assembly, PASCAL languages as well as IBM PCs, H-P computers, VAX minicomputers required. Prefer BSEE or CS with minimum 3 years experience. Contact John Shoup.*

### Radiation Effects Engineers

*Provide circuit design guidance for nuclear radiation environments, radiation effects analysis, and characterization of circuits and components. Must be knowledgeable in instrumentation for transient radiation and S.E.E. testing for Radiation Effects Group. Prefer BSEE with background in device physics and experience in radiation effects. Contact John Shoup.*

### Reliability Engineers

*Responsible for reliability and quality related to design, manufacture and test of HI-REL systems. Must have working knowledge of sampling theory, experiment design, data analysis, and system survivability. Requires knowledge of applicable MIL-SPECs & MIL-STDs. Prefer BS in Physics or Engineering and 5 years related experience. Contact Kevin Kealey.*



### Signal Processing Engineers

*Direct and/or contribute to high performance R&D team in defining new system requirements and in synthesizing innovative design approaches to meet the latest signal acquisition challenges. Requires proven experience in the areas of signal acquisition hardware, signal structures and communications theory, signal analysis algorithm development or microcode development for embedded processors in a HI-REL environment. Prefer MSEE and 7 years applicable experience. Contact Kevin Kealey.*

### Communications Systems Engineers

*Conceptualize and realize systems involving high-speed digital communications systems and equipment for satellite applications. Expertise is required in one or more of the following areas: encoding, encryption, modulation, filtering, carrier and symbol synchronization, equalization, despreading, demultiplexing, deinterleaving or derailing. Proven track record in new business acquisition desired. Prefer MSEE and 7 years applicable experience. Contact Kevin Kealey.*

## SUPPORT

### Components Database Engineers

*Will work in the development of a component database to support design engineering. Successful candidates will have parts engineering experience in a military/aerospace electronics environment. Prefer BSEE and 6 years related parts selection experience. Contact Denise Hruska.*

*Join the people of Motorola's **Government Electronics Group.** The benefits are many, including sunny Arizona — a land as beautiful as it is abundant with recreation and culture.*

*For prompt consideration, forward your resume in confidence to the appropriate technical recruiter at Motorola Government Electronics Group, 8201 E. McDowell Rd., Dept. B846, Scottsdale, AZ 85252; (602) 949-3759. An Equal Opportunity/Affirmative Action Employer. U.S. Citizenship Required. Principals only, please.*

The Mind to Imagine
THE SKILL TO DO

**MOTOROLA INC.**
**Government Electronics Group**
*Advanced electronics for a more productive world.*

# Delco Systems Operations
## Santa Barbara

If you have been looking for a career that both challenges and rewards your expertise, **Delco Systems Operations** has the answer. We have immediate openings in the following categories.

**Principals Only.** Most positions require U.S. Citizenship.

## CAE Engineers

Specify, evaluate, design, integrate and support state-of-the-art CAE tools for all phases of designs from Systems to VLSI components. Operate in a diverse computing environment ranging from engineering workstations to mainframe. Available positions include:

### IC Design Support Engineer

VLSI design experience, including related CAE tools; VLSI layout, layout verification, circuit simulation, placement and routing, silicon compilation. Reference Job Code A-41.

### Simulation Support Engineer

Experience with logic design and logic and fault simulation. Reference Job Code A-42.

### Test Support Engineer

Experience with DFT, IC test, PCB test and test generation tools. Reference Job Code A-43.

### Design Management Support Engineer

Experience with configuration management of design environments. Software background, especially databases and programming languages. Reference Job Code A-44.

### Software Development Engineer

Experience with development and integration of CAE software. Reference Job Code A-45.

### Apollo System Administrator

Experience with system administration, AEGIS or UNIX preferred. Reference Job Code A-46.

### Advanced CAE Engineers

Experience with development and application of CAE, including simulation, test, PCB design, IC design, silicon compilation and design management. MS or PhD required. Reference Job Code A-47.

**BS/MS in Computer/Electrical Engineering or Computer Science required.**

**As part of General Motors you will experience growth and opportunity on the leading edge of Aerospace Technology. Delco Systems Operations offers a professional environment and outstanding benefits. Send resume, referencing job code with detailed salary and educational history to:**

**Delco Systems Operations**
**6767 Hollister Avenue**
**Goleta, CA 93117**

**Delco Electronics Corporation**
**Subsidiary of GM Hughes Electronics**
Equal Opportunity Employer

---

Computer Systems Engineers/Designers

# READ

The programs are leading-edge, exciting, important, and growing.

# BETWEEN

Revenues nearing a half-billion, people exceeding 6,000 and growing.

# THE

Advanced programs/technologies in Simulation/Modeling

# LINES.

## DoD PROTOTYPE SIMULATOR DEVELOPMENT

- **SOFTWARE SYSTEMS ENGINEERS:** Experience with all facets of software life cycle development including ADA design methodologies, and familiarity with cartographic or weapons simulator applications. Positions located in McLean, VA.
- **DATABASE DESIGNERS:** Broad experience with development of advanced databases and software. Must have knowledge of cartographic databases and DMA digital and hardcopy products. Desire exposure to weapons simulator development, ADA design and 3-D graphics. Positions located in McLean, VA.

For immediate consideration, please send your resume in confidence to: **Planning Research Corporation, Government Information Systems, 1500 Planning Research Drive, Department TS-9 , McLean, Virginia 22102.** U.S. citizenship required. An Equal Opportunity Employer M/F/H/V.

prc

**Planning Research Corporation**
Government Information Systems

Government Support Systems Division

# TPS ENGINEERING OPPORTUNITIES

## As The Largest Supplier Of Test Programs, We're Taking Technology Even Further In Florida

Why work anywhere else when you can join Harris Government Support Systems Division (GSSD) in Orlando, Florida? We're recognized as the largest single supplier of test programs for all possible applications. We can offer you the challenges you seek plus a lifestyle you'll enjoy. Orlando offers a comfortable way of living with outstanding recreational choices, no state income tax and affordable housing. The following outstanding opportunities are currently available:

### TPS AND TEST SYSTEMS

You will be responsible for technical and project planning and leadership on a variety of programs across the full range of the test business area. Responsibilities also include the development of testability analyses, test and program requirements, test system-element specifications development, ATE/TPS/UUT compatability and augmentation. You will also be responsible for automatic test tool development and utilization, advanced concepts development and provide guidance and assistance to engineers in the development of TPS HW/SW elements.

To qualify for these challenging opportunities, you should have test system and/or test program set expertise and experience. A BSEE and a minimum of 5 years' applicable experience are required. Excellent communication skills are also required. An MSEE is preferred.

**For immediate, confidential consideration, please forward your resume to: Kathy Radatz, Harris GSSD, Dept. EDN, 1401 S. Semoran Blvd., Bldg. 6, Winter Park, FL 32792. Or call COLLECT at (305) 657-0400 ext. 205.**

### PROJECT ENGINEERS Hardware

In these positions, you will be responsible for administering the total work package consisting of scope, budget, schedule and man hours estimation. The work package activities will involve various disciplines such as drafting, electrical and mechanical engineering, prototype engineering, materials and outside vendors. in addition, you will conduct program engineering activities including interdepartment and customer interface, conceptual design, proposal development and PDR/CDR presentations.

To qualify for these challenging opportunities, you should have a BSEE or BSME and 10 years' related experience including 3 years' project lead responsibility.

**For immediate, confidential consideration, please forward your resume to: Rich Melecci, Harris GSSD, Dept. EDN, 1401 S. Semoran Blvd, Bldg. 6, Winter Park, Florida 32792. Or call COLLECT at (305) 657-0400, ext. 205.**

As part of the Fortune 200 Harris Corporation, Florida's largest industrial employer, GSSD offers an excellent compensation/benefits package and relocation assistance.

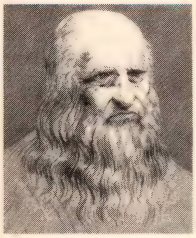
**We are an equal opportunity employer M/F/H/V.**

**U.S. Citizenship Required.**

HARRIS

# WE'RE LOOKING FOR ANOTHER DA VINCI.

# AND ANOTHER DA SILVA.



Leonardo Da Vinci envisioned engineering concepts during the Renaissance that weren't realized until the 20th century. Diedre Da Silva is developing guidance concepts that will impact flight technologies in the 21st century. Yet unlike Leonardo, Diedre has the people and the technological resources behind her at Convair to take her ideas from design to production. And with the variety of company health, recreation and retirement benefits that Convair provides, she's able to live the kind of balanced life that was idealized in Leonardo's times.

If you're looking for creative opportunities and have 3 or more years' of professional experience, apply for a position with us in: ***RCS signature technology, radar absorbing materials, DoD software quality engineering, or industrial and manufacturing engineering.*** Send your resume to: I.J. Brilliant, Professional Staffing, P.O. Box 85357, MZ 11-1340-1422, San Diego, CA 92138.

Who knows? You might become the next Da Silva.

**GENERAL DYNAMICS**

*Convair Division*

Equal Opportunity Employer/Principals Only

Although there is a strike currently in progress, the positions offered within this ad are not within the affected bargaining unit.

# SOFTWARE ENGINEERS

Norden Systems, Inc., a pacesetter in diverse technologies and one of the nation's major suppliers of complete military electronic systems, is still growing. Present and future customer commitments have resulted in excellent copportunities for individuals to join us at our Norwalk (Southern Connecticut) facilities.

The qualified candidates should possess a degree in Electrical Engineering, Math, Physics or Computer Engineering with at least 3+ years' experience. Responsibilities include systems analysis of real time airborne radar software. Knowledge of radar signal processing and control necessary. Hardware/software integration desirable.

We offer an excellent starting salary and company-paid benefits, which include a dental plan and a tuition assistance program, along with a prime southwestern CT location that offers urban, rural and shoreline pleasures.

Please send resume, including salary history to **Mark Smith, Dept. EDN-820, P.O. Box 5300, Norwalk, CT 06856. Or call COLLECT (203) 852-4738.** We are an equal opportunity employer.

**UNITED TECHNOLOGIES NORDEN SYSTEMS**

# LORAL

Loral Information Display Systems, a division of Loral Corporation (NYSE), designer of digital electronic information systems and graphic displays for military applications, continues to grow and has immediate openings for:

**PROGRAM MGR:** BSEE with MBA preferred. Requires 10 yrs. experience in Program Mgt. in a military electronics/avionics development and production program.

**ANALOG/CRT DISPLAY ENGR:** BSEE with 3-7 yrs. experience in CRT circuit design. Background in designing for military electronic/avionic applications desired.

**QUALITY ENGR.—PRINCIPAL:** Technical degree with business background preferred. Requires 8-10 yrs. experience in Quality Engineering in a military manufacturing environment. Must have experience in MIL Q 9858 and bids and proposals. Background in configuration management and high rel soldering a plus. Must possess good verbal and written communication skills plus computer systems experience.

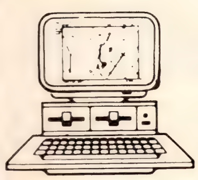
**SR. RELIABILITY ENGR.:** Engineering degree plus 7-10 yrs. direct experience in military reliability functions. Experience in MTBF, design analysis, failure analysis and corrective action programs in military applications.

**SR. MAINTAINABILITY ENGR.:** Engineering degree plus 7-10 yrs. direct experience in military maintainability. Must be knowledgeable in MTTR calculations, creation of program requirements and built in test.

**MECHANICAL ENGR.:** BSME or MSME with 2-5 yrs. experience in electromechanical packaging of airborne equipment for military applications. Must be knowledgeable of MIL-E-5400, MIL std 454, MIL std 810 and military documentation requirements.

Loral Information Display Systems offers a ground floor opportunity in a progressive electronics company. Our location is suburban Atlanta in our own office park. We offer top industry pay and benefits. If interested, please **call (collect) 404/448-1604** or send resume to:

**LORAL INFORMATION DISPLAY SYSTEMS**
**Dept. D237**
**6765 Peachtree Industrial Blvd.**
**Atlanta, GA 30360**
**Attn: Robert C. Hall.**



We are an equal opportunity employer, M/F/H/V.
U.S. Citizenship is required.

**LORAL**
**INFORMATION DISPLAY SYSTEMS**
A DIVISION OF LORAL CORPORATION

# ADVERTISERS INDEX


Abbott—Power Supply Div . . . . . 105
ABC-Taiwan Electronics Corp . . . . . 316
ACCELTechnologies Inc . . . . . 316
Acculex Corp . . . . . 260
Advanced Micro Devices . . . . . 12-13
Advanced Microcomputer Systems Inc . . . . . 318
AIE Magnetics . . . . . 315
Airpax Corp/Cambridge Div . . . . . 158
Alexander Batteries . . . . . 313
Amatom Electronic Hardware . . . . . 264
Amco Engineering . . . . . 265
American Automation . . . . . 80
American Research and Engineering . . . . . 301
AMP Inc . . . . . 128-129
Amperex Electronic Corp* . . . . . 306
Analog Devices Inc . . . . . 287
Archimedes Software* . . . . . 141
Arnold Magnetics Corp . . . . . 178A&B
ATC Power Systems . . . . . 262
AT&T Technologies . . . . . 200-201
Atlanta Signal Processors Inc . . . . . 234
Ault Inc . . . . . 272
Autodesk Inc . . . . . 89
Avocet Systems Inc . . . . . 198-199
Bay R&D . . . . . 153
Behlman Engineering Corp . . . . . 274
Beta Automation Inc . . . . . 314
BICC-Vero Electronics Inc . . . . . 193
Bishop Graphics Inc . . . . . 257
BP Microsystems . . . . . 317
Brooktree Corp . . . . . 278-279
Burndy Corp . . . . . 235-236
Burr-Brown Corp* . . . . . 95, 282
BV Engineering . . . . . 314
Bytek Corp . . . . . 316
California Eastern Labs Inc . . . . . 71
Capital Equipment Corp . . . . . 316
Cardinal Technologies Inc . . . . . 302
Carroll Touch Inc . . . . . 92
Case Technology . . . . . 82
Chartered Electronics Industries/
Singapore Tech Inc** . . . . . 106
Cherry Electrical Products Inc . . . . . 25
Chomerics Inc . . . . . 241
Circo Craft . . . . . 11
C&K Components Inc . . . . . 6
Comair Rotron Inc . . . . . 96
Computer Products Inc . . . . . 195
Connector Corp . . . . . 304
Conversion Devices Inc . . . . . 318
Cybernetic Micro Systems . . . . . 314
Cypress Semiconductor . . . . . 35-40
Dage Precision Industries Inc . . . . . 280
Daisy Systems Corp . . . . . 15, 16-17
Dale Electronics Inc . . . . . 1
Dash, Straus, and Goodhue . . . . . 2
Data Delay Devices . . . . . 277
DATA Inc . . . . . 284
Data I/O Corp . . . . . 8
Datakey Inc . . . . . 312
Datel . . . . . 76
Deltrol Controls . . . . . 316
Digelec Inc . . . . . 313
Digital Electronics Corp . . . . . 218
Dolch Logic Instruments . . . . . 320
Dow Corning . . . . . 354
Eaton Corp . . . . . 318
EG&G Rotron . . . . . 291
Elan Digital Systems . . . . . 324
Eldre Components Inc . . . . . 314
Epotek Corp . . . . . 96
ESC Electronics Corp . . . . . 168
E-T-A Circuit Breakers . . . . . 315
ETA Industries . . . . . 256
Fairchild Communications . . . . . 177
Fairchild Memory and High Speed Logic . . . . . 123
Force Computers Inc . . . . . 97, 98-99
Forth Inc* . . . . . 217
Fujitsu Components of America Inc* . . . . . 106
Fujitsu Microelectronics Inc* . . . . . 298
Futaba Corp of America . . . . . 270
GalaGraph Inc . . . . . 318
Garret Corp . . . . . 178A&B
Gates Energy Products Inc . . . . . 54-55
GCOM Inc . . . . . 46
GE/Microelectronics . . . . . 44-45
GE Plastics . . . . . 326
General Instrument, Optologic Div . . . . . 126
GE/RCA Solid State . . . . . 155-157, 240
George Risk Industries . . . . . 94
Gould Computer Systems . . . . . 139
Gould Test & Measurement . . . . . 112-113
Harris Microwave Semiconductor . . . . . 69
Harris Semiconductor Custom
IC's Div . . . . . 30, 238-239
Harris Semiconductor Products . . . . . 202
Harris/Scientific Calculations Inc . . . . . 273
Hewlett-Packard Co . . . . . 28-29, 48, 77,
127, 159-162, 190, 248,
Honeywell Test Instrument Div . . . . . 179
Hughes Aircraft Co/Connecting Devices Div . . . . . 132
Hybrid Systems Corp . . . . . 285
IEE . . . . . 57
Imagraph Corp . . . . . 315
Information Scan Tech . . . . . 315
Infrared Industries Inc . . . . . 297
Inland Motor . . . . . 292
Inmos Corp . . . . . 101
Integrated Circuits Inc* . . . . . 296, 318
Integrated Device Technology Inc . . . . . 212-213
International Rectifier . . . . . 62
Intusoft . . . . . 314
IRC Inc . . . . . 281
Janco Corp . . . . . 310
Jenson Transformer . . . . . 168
John Fluke Manufacturing Co Inc . . . . . 131
Keithley Instruments . . . . . 41, 229
Keithley Instruments Industrial Products . . . . . 49
Kepco Inc . . . . . 167
K-Systems Inc . . . . . 314
Linear Technology Corp . . . . . 242
Loctite Corp . . . . . 300
Logical Devices Inc . . . . . 314
Logical Systems Corp . . . . . 318
Marconi Electronic Devices** . . . . . 216-217
Maxtor . . . . . 58
McLean Engineering . . . . . 30
Medinova Corp . . . . . 315
Melcher . . . . . 286
Mepco/Centralab . . . . . 78-79
Micro Switch . . . . . 169
Micro/Sys . . . . . 72
Mini-Circuits Laboratories . . . . . 3, 4, 26-27, 245
Molex Inc . . . . . 356
Monolithic Memories Inc . . . . . C2
Motorola Microcomputer MCD . . . . . 42-43
Motorola Semiconductor Products Inc . . . . . 52-53, 111
M S Kennedy Corp . . . . . 288
Murata Erie North America Inc* . . . . . 216
National Semiconductor Corp . . . . . 210-211
NCR Corp . . . . . 253
NEC Corp . . . . . 170-171
Nicolet Test Instruments Div . . . . . 314, 316
Nova Sensor . . . . . 293
Novotechnik US Inc . . . . . 49
Octagon Systems . . . . . 315
Omega Engineering Inc . . . . . 313
Omnire . . . . . 290
1553 Test Systems . . . . . 314
OrCAD Systems Corp . . . . . 182
OU-PIN Enterprise Co** . . . . . 319
Panasonic Industrial Co* . . . . . 88
Philips Elcoma Div** . . . . . 142-143
Philips Test & Measuring Instruments Inc** . . . . . 95
Pico Electronics Inc . . . . . 311
Plessey Co . . . . . 258
Plessey Microsystems . . . . . 197
Polytron Corp . . . . . 316
Power Conversion . . . . . 46
Powerex Inc . . . . . 266-267
Precision Monolithics Inc . . . . . 189
Pro-Lib Inc . . . . . 315
Qua Tech Inc . . . . . 317
Quelo Inc . . . . . 316
Rapid Systems . . . . . 303
Raytheon . . . . . 67
Raytheon Ocean Systems . . . . . 309
Ready Systems . . . . . 90-91
Rifa Inc A B** . . . . . 141
Robinson-Halpern . . . . . 313
Rogers Corp . . . . . 294, 318
Samtec Inc . . . . . 317
Schroff . . . . . 230
SCI Technology Inc . . . . . 172
Seagate Technology . . . . . 50-51
Seeq Technology Inc . . . . . 255
SGS Semiconductor Corp* . . . . . 102-103
Sheldahl Inc . . . . . 251
SI Tech . . . . . 316
Siecor Corp . . . . . 130
Siemens AG** . . . . . 102-103
Siemens AG . . . . . 60-61
Siemens Corp, Special Products Div* . . . . . 151, 289
Signal Transformer Co Inc . . . . . C4
Signetics Corp . . . . . 180-181
Single Board Solutions . . . . . 313
SI-TAC Connectors Inc . . . . . 307
Soltec Corp . . . . . 146
Sony Corp of America . . . . . 214
Spectrum Software . . . . . 47
Sprague Electric Co . . . . . 31
Sprague-Goodman Electronics Inc . . . . . 315
Standard Oil . . . . . 324
Stimpson Co Inc . . . . . 295
Switching Power Inc . . . . . 34
Syltel . . . . . 125
Targa Electronics Systems Inc . . . . . 94
T-Bar Inc . . . . . 322
Technitrol Inc . . . . . 178
Tektronix In . . . . . 33-34, 73-74, 75, 275-276
Tektronix-CAE Systems . . . . . 85, 87
Telebyte Technology Inc . . . . . 125, 277
Teledyne Relays . . . . . 233
Texas Instruments Inc . . . . . 107-110
Thomas and Betts Corp . . . . . 14
Thomson Components-Mostek* . . . . . 142-143
Torin Engineered Blowers . . . . . 305
Toshiba America Inc/Memory Div . . . . . 18-19
Toshiba America Inc/Semiconductor Div . . . . . 269
TRW/Cylindrical Connector Div . . . . . 259
Unemac Products Inc . . . . . 88
Universal Data Systems . . . . . C3
Valid Logic Systems Inc . . . . . 144-145
VideoLog Communications . . . . . 215
Vishay Resistive Group . . . . . 196
Visionics Corp . . . . . 271, 317
VTC Inc . . . . . 23
Wintek Corp . . . . . 315, 318
Yokogawa Corp of America . . . . . 263
Zax Corp . . . . . 64
Ziatech Corp . . . . . 20
Zilog Inc . . . . . 247


## Recruitment Advertising

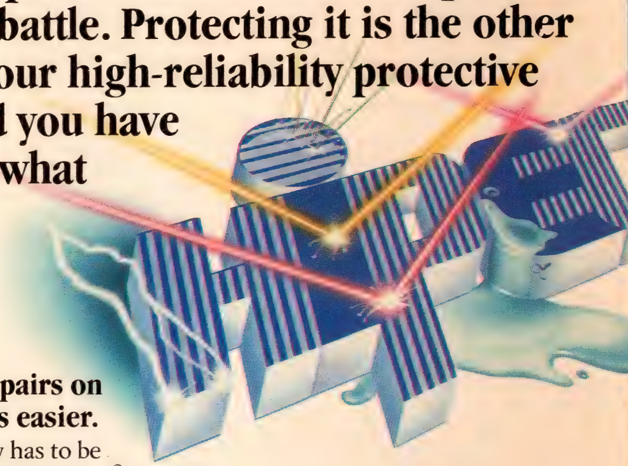

American Electronic Labs . . . . . 348
American Systems Corp . . . . . 342
Bell Aerospace/Textron . . . . . 341
Delco . . . . . 346
Dunhill of Indianapolis . . . . . 348
EG&G . . . . . 330
Emerson Electric . . . . . 338
E-Systems, ECI Div . . . . . 344
E-Systems, Greenville . . . . . 333
Ford Aerospace . . . . . 335
GE . . . . . 331
General Dynamics . . . . . 351
Harris Corp/GSSD . . . . . 350
Jack Porter Assoc . . . . . 348
Litton . . . . . 343
Lockheed, Sunnyvale . . . . . 349
Loral . . . . . 351
McDonnell Douglas Astronautics . . . . . 334
Missouri Div of Emp . . . . . 348
Motorola Gov't Electronics . . . . . 345
Pan Am Word Services . . . . . 340
Planning Research Corp . . . . . 346
Raytheon Equip Dev Lab . . . . . 339
Raytheon Missile Syst Div . . . . . 347
Systems Research Labs . . . . . 332
Tracor Aerospace . . . . . 342
UNISYS . . . . . 336
United Technologies/Norden . . . . . 351


*Advertiser in US edition
**Advertiser in International edition

*Dow Corning Presents*

# A Design Digest of Electronic Reliability

**Designing a high-performance electronic product is only half the battle. Protecting it is the other half. Demand our high-reliability protective materials and you have won. Here is what we mean:**



### New thermally-conductive elastomer conducive to many uses.

For thermal dissipation that protects perfomance, choose new SYLGARD® Q3-6605 thermally-conductive elastomer. It is especially useful as a thermally-conductive adhesive to bond ceramic hybrid circuit packages to heat sinks. Other uses include bonding or potting power supplies, coils, heavy-duty relays, and similar units. Primerless, too.

**CIRCLE NO 186**

### Protective silicone gels relieve stress and improve reliability.

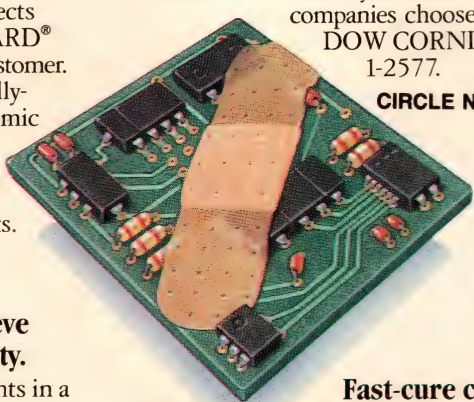
When you encapsulate components in a silicone gel, you protect them against hostile environments, temperatures as low as −80°C and more. DOW CORNING® silicone gels also cushion components against stress and vibration. We offer a broad choice of one component and two component materials; for room temperature and heat cure processes.

**CIRCLE NO 187**

### Coating makes repairs on PC boards easier.

A PC board coating simply has to be reliable. And with DOW CORNING® 1-2577 conformal coating you get more: easy repairability when components need replacing. Add superior protection in extreme environments, versatile processing with dipping or spraying, and you have all the reasons major automotive and military electronics companies choose DOW CORNING 1-2577.

**CIRCLE NO 188**



### Fast-cure coating for fiber optics.

OPTIGARD® optical fiber coating UV-cures in just 0.3 seconds—5 to 20 times faster than thermal-curing coatings. And it protects against moisture and "micro-bends" better than acrylate coatings. It's part of the OPTIGARD family which includes fiber optics grade $SiCl_4$ core and cladding and OPTIGARD cable filler.

**CIRCLE NO 189**

### Life insurance for semiconductors.

Stress. Moisture. Ion contamination. Voltage linkage. Alpha particles. All are killers of your devices, robbers of reliability. Now you have a defense against them. HIPEC® coatings protect semiconductors and hybrids through a wide range of temperatures and environments. They're available in a variety of forms from gel to firm elastomer and resins. And HIPEC coatings are easier to process than other high-performance materials.

**CIRCLE NO 190**

### There's more.

There's also our unique team of experts whose only mission is to develop and customize coatings, adhesives, dispersions, sealants, and components specifically for you. Supported by dedicated research and manufacturing facilities, we will help you meet tomorrow's challenges today. Ask about our Specialty Elastomers, Group.

Write Department 7013, Midland, MI 48686-0994.

**CIRCLE NO 191**

**DOW CORNING®**

DOW CORNING

Dow Corning, Sylgard, Optigard and Hipec are registered trademarks of Dow Corning Corporation.

# LOOKING AHEAD

EDITED BY CYNTHIA B RETTIG

**ESTIMATES AND PROJECTIONS OF FIBER-OPTIC COMPONENTS MARKET BY END USERS ($ MILLIONS 1985 TO 94)**

| END USER | 1985 | 1986 | 1990 | 1994 | AVERAGE ANNUAL GROWTH 1985 TO 94 |
|---|---|---|---|---|---|
| TELECOMMUNICATIONS | 460 | 584 | 1062 | 1510 | 14.1% |
| COMPUTER INTERCONNECT | 20 | 30 | 348 | 913 | 52.0 |
| SUBSCRIBER LOOP | — | — | 38 | 141 | 39.0* |
| MILITARY | 60 | 90 | 425 | 843 | 34.3 |
| BROADCASTING AND CABLE TV | 6 | 9 | 38 | 70 | 31.5 |
| OTHERS | 6 | 7 | 19 | 35 | 21.6 |
| TOTAL | 552 | 720 | 1930 | 3512 | 22.8% |

*1992-1994 GROWTH

*(SOURCE: CORPORATE STRATEGIC INTELLIGENCE)*

## F-O component market to reach $3.5B by 1994

Over the past 15 years, fiber-optic components, which facilitate the transmission of data by light impulses through optical glass fiber, have found applications in voice, data, and video transmission. The sales of such products totaled $720 million in 1986 and should reach $3.5 billion by 1994, according to Corporate Strategic Intelligence (CSI) of Middlebush, NJ. Growth from now until 1990 is expected to be moderate because of the slowdown in long-haul installations, but it will intensify later for LAN and subscriber-loop markets.

The business consulting firm expects that, as the technology develops further, fiber optics will replace copper wire for single-mask communication uses. Optical-fiber technology has various advantages over other transmission media, including coppper-wire, microwave, and satellite media. It solves several critical network problems by offering advances such as high-capacity broadbandwidth cable, nonflammability, small size and low weight, high security, reliability of data transfer, and immunity from electromagnetic interference.

The five major product categories —fiber/cable, connectors, coupler/splices, emitters, and detectors—will experience an average annual growth rate of 22.8% from 1985 to 1994. Predictably, the fiber/cable products themselves constitute the largest portion of the fiber-optics communication market, representing about 70% of the total sales. They accounted for $514 million in 1986, a figure that should increase to roughly $2.4 billion by 1994. The 10.5% share held by emitters last year is expected to grow to 12% by 1994, for a $432 million market. The market share of detectors will also expand during the period, increasing from 10 to 11.5% to claim $400 million in sales in 1994.

CSI expects connectors to claim 6.5% of the market in 1994, down from 7% in 1986. Total sales for connectors should reach $229 million in 1994. Although accounting for only 1% of the total market over the period, coupler/splices will see sales increase from $7 million in 1986 to $31 million in 1994.

CSI predicts that component prices will decline this year and that product improvements will spur businesses to change and demand products in short-haul applications, such as data communication, computer/LAN, and video/CATV.

Increases are also expected in the sales and use of long-wavelength LEDs based on the indium phosphide semiconductor system for military applications and for civilian data communcations. Long-wavelength LEDs exhibit a good tolerance to wide temperature swings, mechanical shocks, and vibrations. Multimode fibers are expected to find broader use as well through the end of this period.

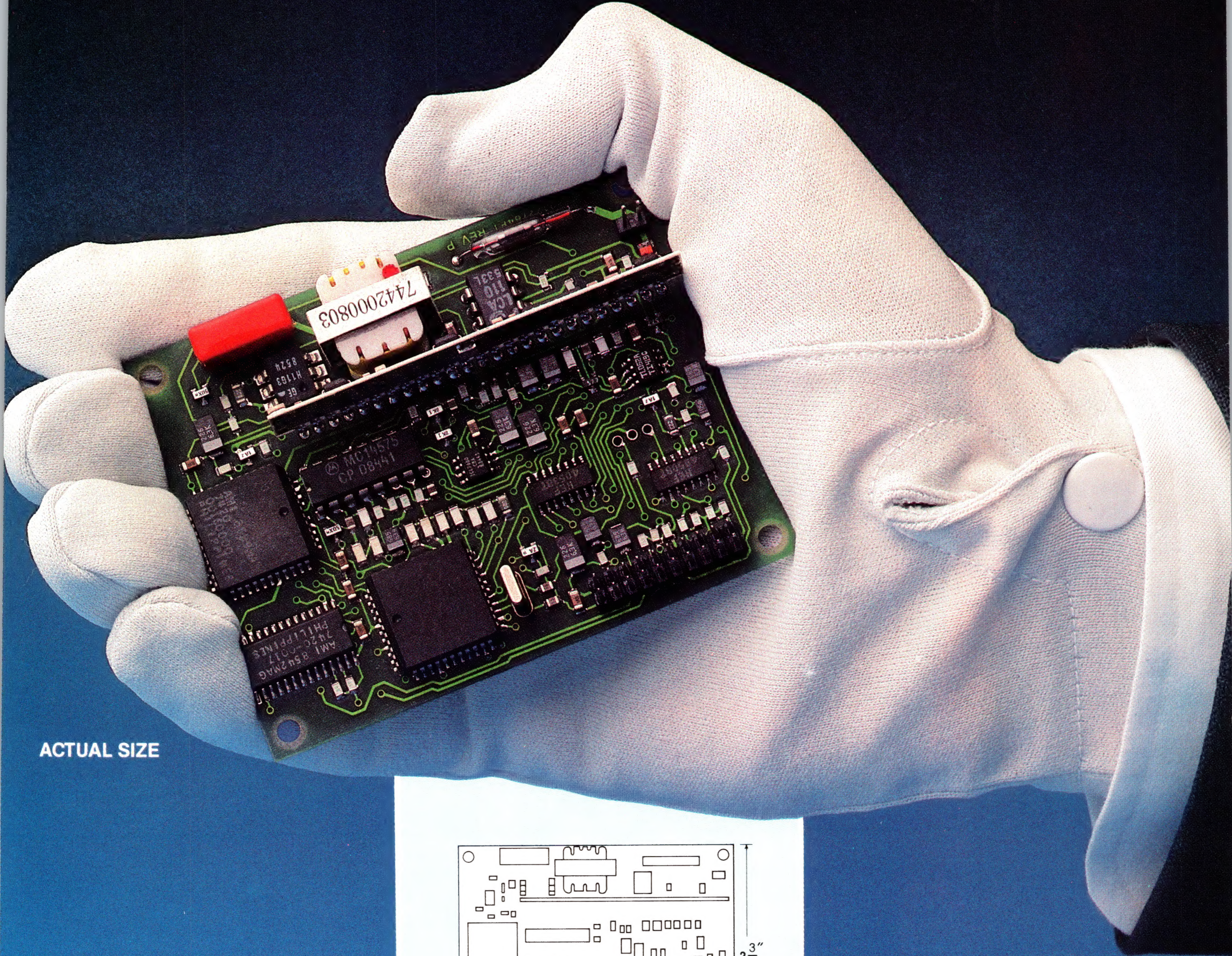
CSI defines long-haul communications as those that traverse over 50 km. Medium-haul distances are between 15 and 50 km, and short-haul communications are generally defined as those that travel between 10 and 15 ks.

In terms of end users, the telecommunications industry will continue to demand the largest segment of the market, reaching $1.51 billion by 1994. Its growth rate over the period will be the lowest, however, at 14.1%. The fastest growing end-user segment will be the computer-interconnect industry, which will grow at an average annual rate of 52%.

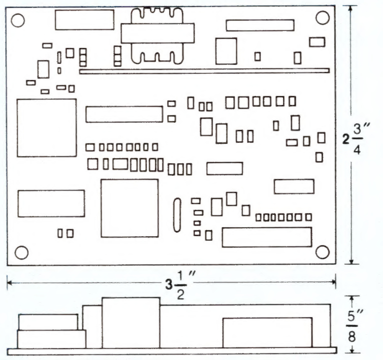
## Major thin-film markets to grow at 15% average rate

The markets for thin films that are applied by physical and chemical vapor deposition processes will create a $4.1 billion industry by 1991, according to the Gorham Advanced Materials Institute of Gorham, ME. It estimates that the 1986 value of the industry was $3 billion. Applications for optical, optoelectronic, and electronic uses claimed approximately $2.6 billion of the market; coatings for cutting tools and decorative products made up the rest.

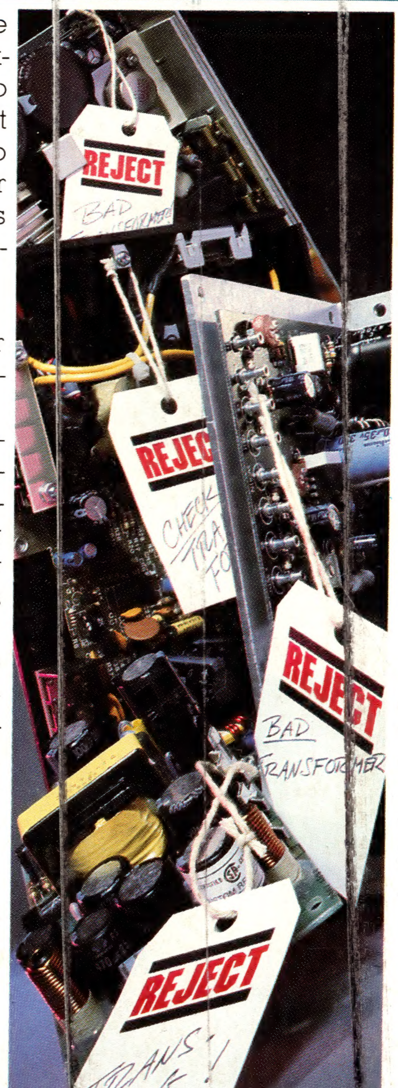
The institute predicts that the markets for electronic, optoelectronic, and optical applications will grow at a compound annual rate close to 15% through 1992. The demand for equipment and consumables within the industry should increase at annual compound rates of 12 and 15%, respectively, for a combined market value of $2.3 billion in 1992.







$2\frac{3}{4}''$
$3\frac{1}{2}''$
$\frac{5}{8}''$


REJECT
BAD
REJEC
REJECT
BAD
TRANSFORMER
REJECT
TRANS.
N.G.!




VDE